CR 185642

REPORT

KAPTON WIRE ARC TRACK TESTING

Per Test Procedure KWATT BB01

(NASA-CR-185642) KAPTON WIRE ARC TRACK TESTING: PER TEST PROCEDURE KWATT BB01 (Lockheed Engineering and Sciences Co.) 108 p
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Unclas 0001632

PREPARED BY

POWER DISTRIBUTION/CONTROL SECTION
LOCKHEED ESC
HOUSTON, TEXAS

UNDER CONTRACT NAS 9-17900

FOR
PROPULSION AND POWER DIVISION/EP5
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OCTOBER 1990

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TEST SUMMARY

INTRODUCTION

This report presents the results of Kapton wire arc tracking tests performed at JSC in 1990 using test procedure KWATT BB01. The tests were performed to gather data for use in assessing the safety of the Space Shuttle Orbiter wiring which is predominantly Kapton insulated.

OBJECTIVES

The main objectives for the testing were to investigate with respect to arc tracking the effectiveness of circuit protection devices and the influence of the following:

- Wire Size
- Voltage Levels
- Bundling
- Electrical Loading
- Installation Hardware

TEST METHOD

The wiring used in the testing was taken from Orbiter stock and therefore identical to the Orbiter wiring. The wire is Kapton insulated with nickel plated copper conductors, manufactured to MIL-W-81381 per Rockwell Spec. MB0150-048.

The power source utilized was a fuel cell simulator, which is an integral part of the Orbiter Electrical Power Distribution and Control Breadboard at JSC. The non-current limiting power source is capable of delivering 7KW to a load.

Camera coverage and chart recordings of the electrical parameters were made for each test.

First, a pair of insulated wires was cut off even to expose the conductors. Electrical power was then applied to the opposite end of the wires. The arc tracking was initiated by dipping the insulation bared, powered wires into a mixture of graphite powder and copper filings. The use of pure graphite powder was found to be too slow since it provided too much resistance to the shorting circuit. Pure copper granules, on the other hand, did not provide enough resistance, resulting in dead shorts and caused circuit protection devices to remove the power. Methods relying on abrasive techniques were judged to be too time consuming and unreliable.

RESULTS

Analysis of the test results indicate that:

1. Circuit protection devices, as a rule, do not protect against arc tracking. However, no arc tracking was observed when circuit protection was provided by a three ampere rated remote power controller (RPC). Three ampere fuses limited the arc tracking to approximately 1/2 inch of travel. Three ampere circuit breakers allowed greater lengths of arc tracking travel. Figures 1 and 2 provide a summary of the results of this series of tests depicting distance of arc track for each protection device.

2. Re-closing of tripped circuit protection devices reinitiates the arc tracking phenomenon.

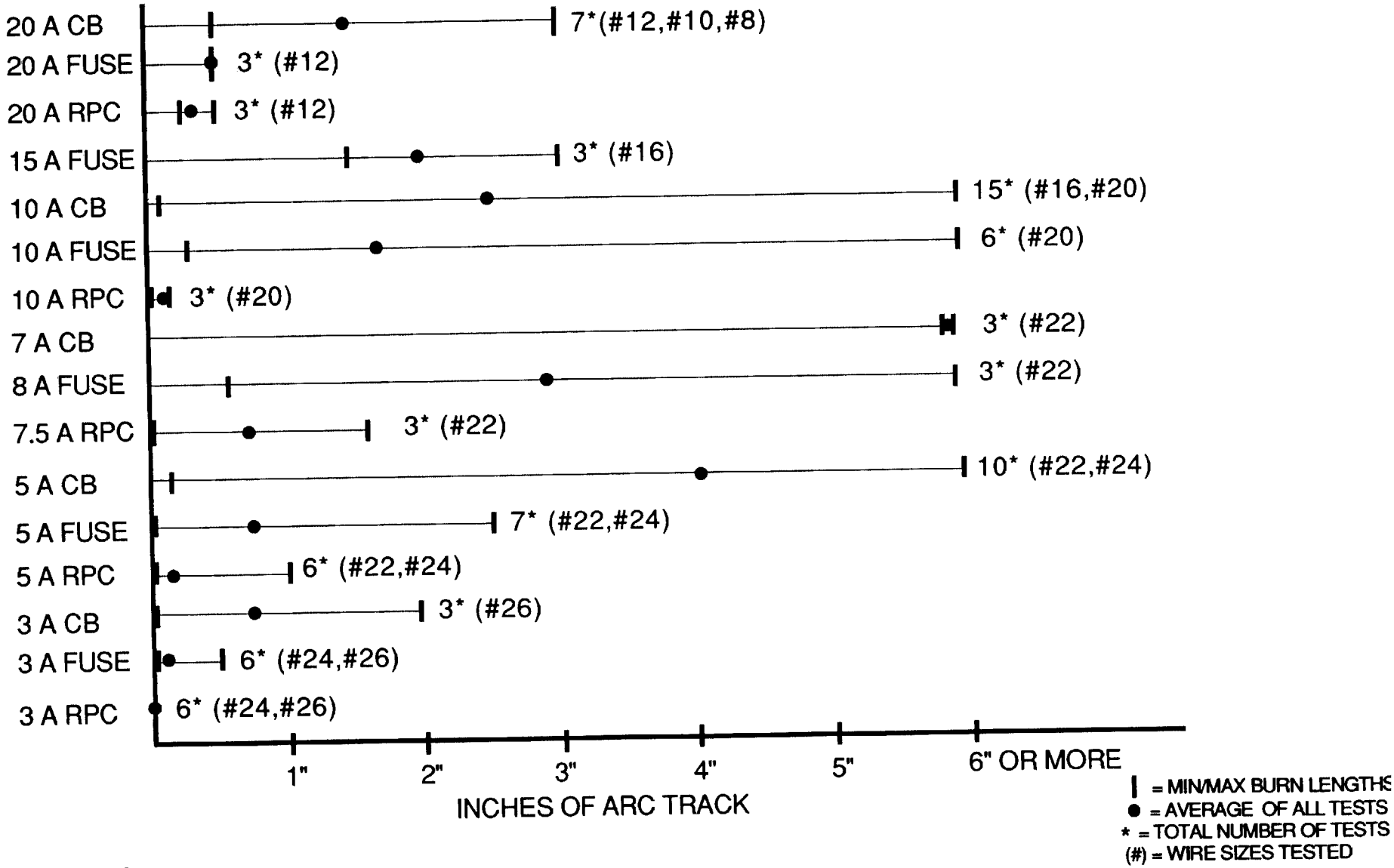
3. Arc tracking of wires in a bundle causes damage to adjacent wiring.

4. The higher the voltage, the easier it is to start the arc tracking. However the distance of arc track travel, before the circuit protection device opens the circuit, appears to be less at the higher voltage.

5. Wire size awg 4 would not arc track, therefore it is assumed that larger sizes also will not arc track. It is thought that there is too much heat sink to allow pyrolysis of the wire insulation.

The entire, as run, test procedure, with the results of each test, is included as Attachment "A" to this report.

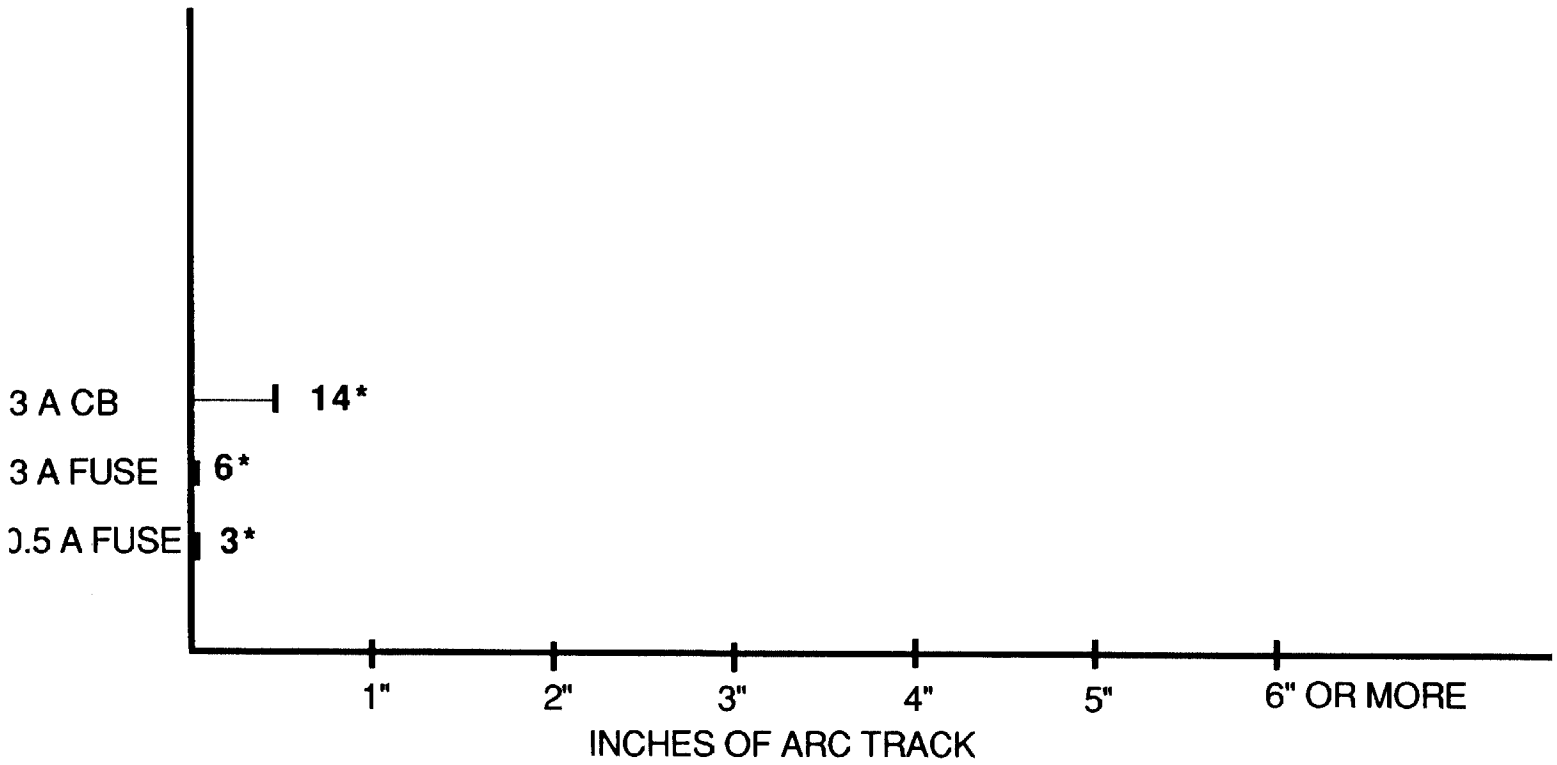
SUMMARY OF 28VDC ARC TRACK TESTS WITH PROPER SIZED CIRCUIT PROTECTION



JULY 1990

FIGURE 1

SUMMARY OF 117VAC ARC TRACK TESTS WITH PROPER SIZED CIRCUIT PROTECTION



JULY 1990

FIGURE 2

January 23, 1990

EPS LAB TEST NUMBER KWATT BB01

TPS# 8000902003

KAPTON WIRE ARC TRACKING TESTS
TEST PROCEDURE KWATT BB01

PREPARED BY
POWER DISTRIBUTION SECTION
LOCKHEED - ESC
HOUSTON, TEXAS
UNDER CONTRACT NAS 9-17900
FOR
AVIONICS SYSTEM DIVISION/EH4
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TEST OBJECTIVE

The objective of this series of tests is to assess the safety of orbiter wiring with respect to arc tracking. This procedure will investigate the following:

1. The effects of wire size.

2. The effectiveness of circuit protection devices.

3. The effects of electrical loading.

4. The effects of installation hardware.

5. The effects of voltage levels.

6. The effects of bundling on propagation.

KAPTON WIRE ARC TRACKING TESTS OUTLINE

In order to assess the safety aspects of the orbiter wiring with respect to arc tracking the following tests will be conducted.

I. Determine the effects of wire size.
   A. Using 28 VDC, perform tests on the following sizes of twisted pairs in the order shown. The intent is to bracket the problem so as to be able to ascertain sizes which will not arc track and also sizes which are difficult to sustain arc tracking.
      1) Awg 24
      2) Awg 10
      If the size Awg 10 refuses to arc track, try:
      3) Awg 12 to progressively smaller sizes.
      If the size Awg 10 arc tracks, try Awg 4.

   B. Using 117/208 VAC 400 Hz, perform tests on the following wire sizes and configurations.
      1) Awg 22, twisted pair: 117V, 1 phase.
      2) Awg 16, twisted pair: 117V, 1 phase.
      3) Awg 24, 4 wire twisted: 208V, 3 phase.
      4) Awg 12, 4 wire twisted: 208V, 3 phase.
      If the size 12 refuses to arc track, try:
      5) Awg 20, 4 wire twisted: 208V, 3 phase.

II. Determine the effectiveness of orbiter circuit protection devices.
   A. Using 28 VDC perform tests on twisted pairs of the following sizes protected by the noted devices.
      1) 24 Awg: 3 amp fuse
      2) 24 Awg: 3 amp RPC
      3) 22 Awg: 5 amp RPC
      4) 22 Awg: 5 amp fuse
      5) 22 Awg: 5 amp CB
      6) 20 Awg: 10 amp CB
      7) 20 Awg: 10 amp fuse

   B. Using 117 VAC, 400 Hz, 1 phase. Perform tests on the following:
      1) 22 Awg, TP: 3 amp CB
      2) 22 Awg, TP: 3 amp fuse
      3) 22 Awg, TP: 0.5 amp fuse

   C. Repeat steps 1, 2, and 3 of part B using 208 VAC, 3 phase.

III. Determine the effects of single power wires arcing to structure. Use 28 VDC and 20 amp CB.
   A. Perform tests on a 22 Awg wire laced in a bundle (for weight purposes) with 6 other wires and laying on a grounded metal plate.
   B. Perform same test but ground the wire laying next to the positive (28 VDC) test wire.

IV. Determine the effect of electrical loading on the arcing wires.
   A. Using size 20 Awg TP wire and a 10 amp CB perform tests with the following loads.
      1) 1 amp
      2) 3 amp

V. Determine the effects of installation hardware. Using size 22 Awg wire, 28 VDC, and 20 amp CB, test with the following in-line hardware.
   A. Wire splice.
   B. Wires spot-tied.
   C. Clamp on bundle.

VI. Determine the effects of DC voltage levels.
   A. Using test sample of Awg 22 twisted pair, perform test with applied voltage of 15 VDC.

   B. Using test sample of Awg 24 twisted, shielded pair, perform tests with the following voltages.
      1) 5 VDC
      2) 15 VDC
      3) 28 VDC

VII. Determine the effects of bundling on propagation. Prepare appropriate test specimens after review of orbiter documentation such as photos, AWLS, etc.

   A. JSC prepared wire bundle consisting of 6 twisted pairs. Three pairs are powered by AC and protected by circuit protection to determine if the arcing of a pair of wires in a bundle will cause surrounding damage and subsequent arcing of other wires in the same bundle.

B. JSC prepared wire bundle to test for the same parameters as in Part A except for the use of DC power. In this test, after each run, the previously unpowered wires, which may be damaged, will be powered up individually through circuit protection devices to determine further damage development.

C. Combine the two bundles of Parts A and B in order to test with a more dense bundle to determine if more heat sinking is a factor. Six tests - three with power wires exterior and three with power wires interior

D. Testing with Rockwell prepared wire bundles duplicating orbiter bundles.

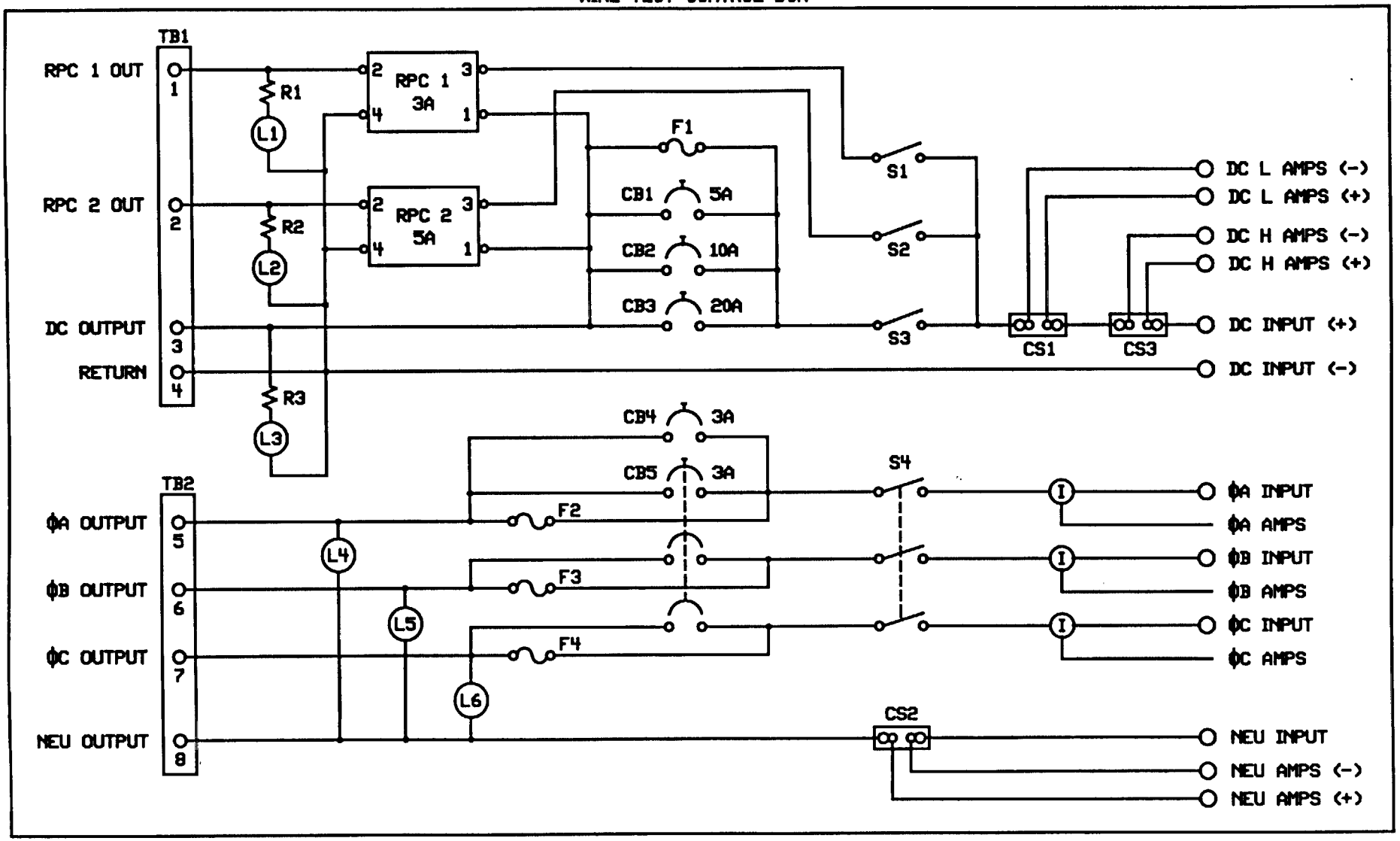
VIII. Determine the effectiveness of orbiter circuit protection devices on all sizes of wire used.

A. Using 28vdc perform tests on the following twisted wire pairs protected by the noted devices.

1) 26 Awg with 3 amp CB
2) 26 Awg with 3 amp fuse
3) 26 Awg with 3 amp RPC
4) 24 Awg with 5 amp CB
5) 24 Awg with 5 amp fuse
6) 24 Awg with 5 amp RPC
7) 22 Awg with 8 amp fuse (in lieu of 7.5 amp fuse)
8) 22 Awg with 7.5 amp RPC
9) 22 Awg with 7 amp CB (in lieu of 7.5 amp CB)
10) 20 Awg with 10 amp CB
11) 20 Awg with 10 amp fuse
12) 20 Awg with 10 amp RPC
13) 16 Awg with 10 amp CB
14) 16 Awg with 15 amp fuse
15) 12 Awg with 20 amp CB
16) 12 Awg with 20 amp fuse
17) 12 Awg with 20 amp RPC
18) 8 Awg with 20 amp CB
19) 8 Awg with 30 amp CBs (in lieu of 35 amp fuse)

IX. Additional Support Testing
See procedure for requirements.

WIRE TEST CONTROL BOX

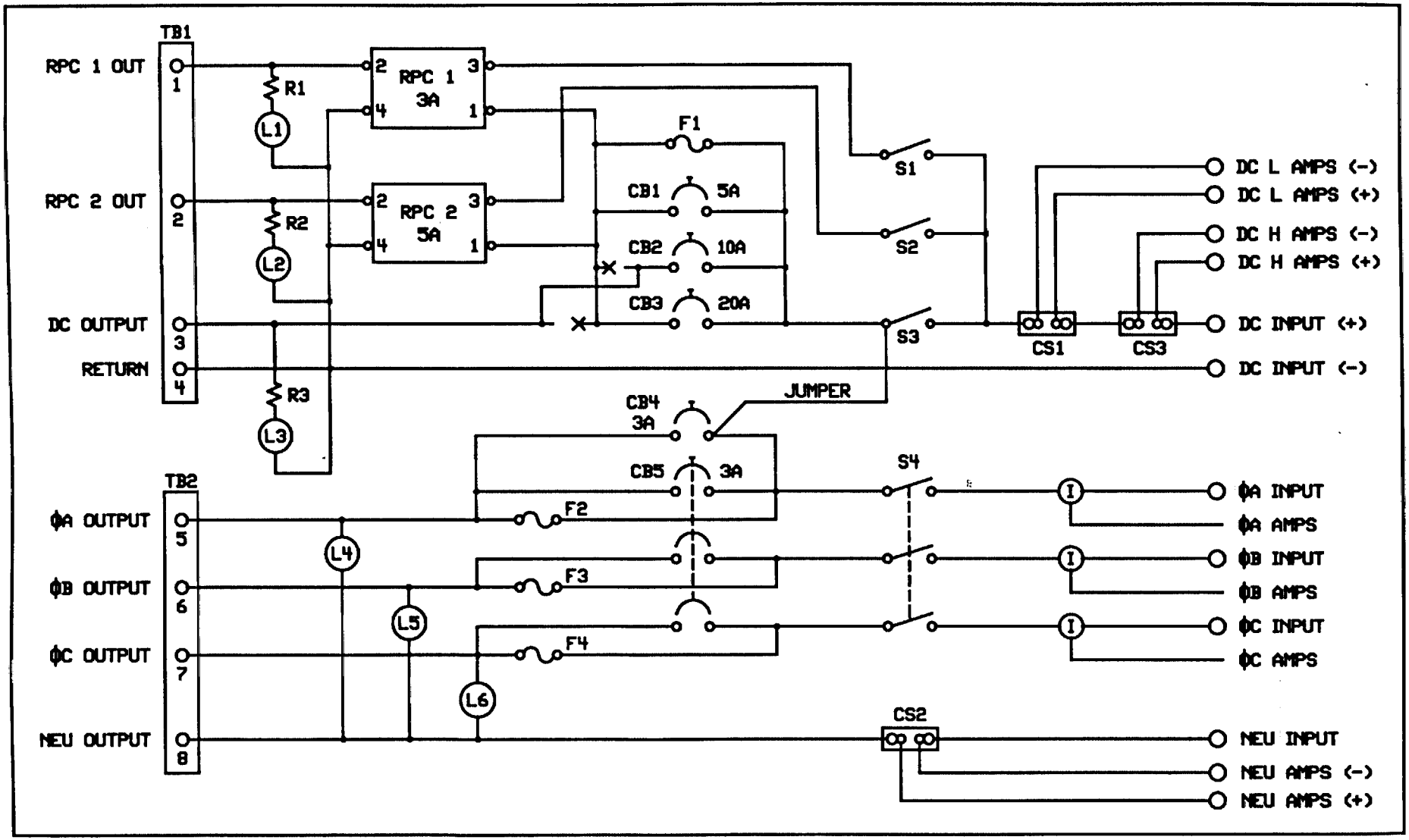


NOTES:

1. ALL WIRING IS #12 AWG.
2. CS1 & CS2 ARE 20 AMP @ 100mV SHUNTS.
3. CS3 IS 500 AMP @ 50mV SHUNT.
4. R1-R3 ARE 412 OHM RESISTORS.
5. L1-L6 ARE INDICATOR LAMPS.

FIGURE 1

WIRE TEST CONTROL BOX



NOTES:

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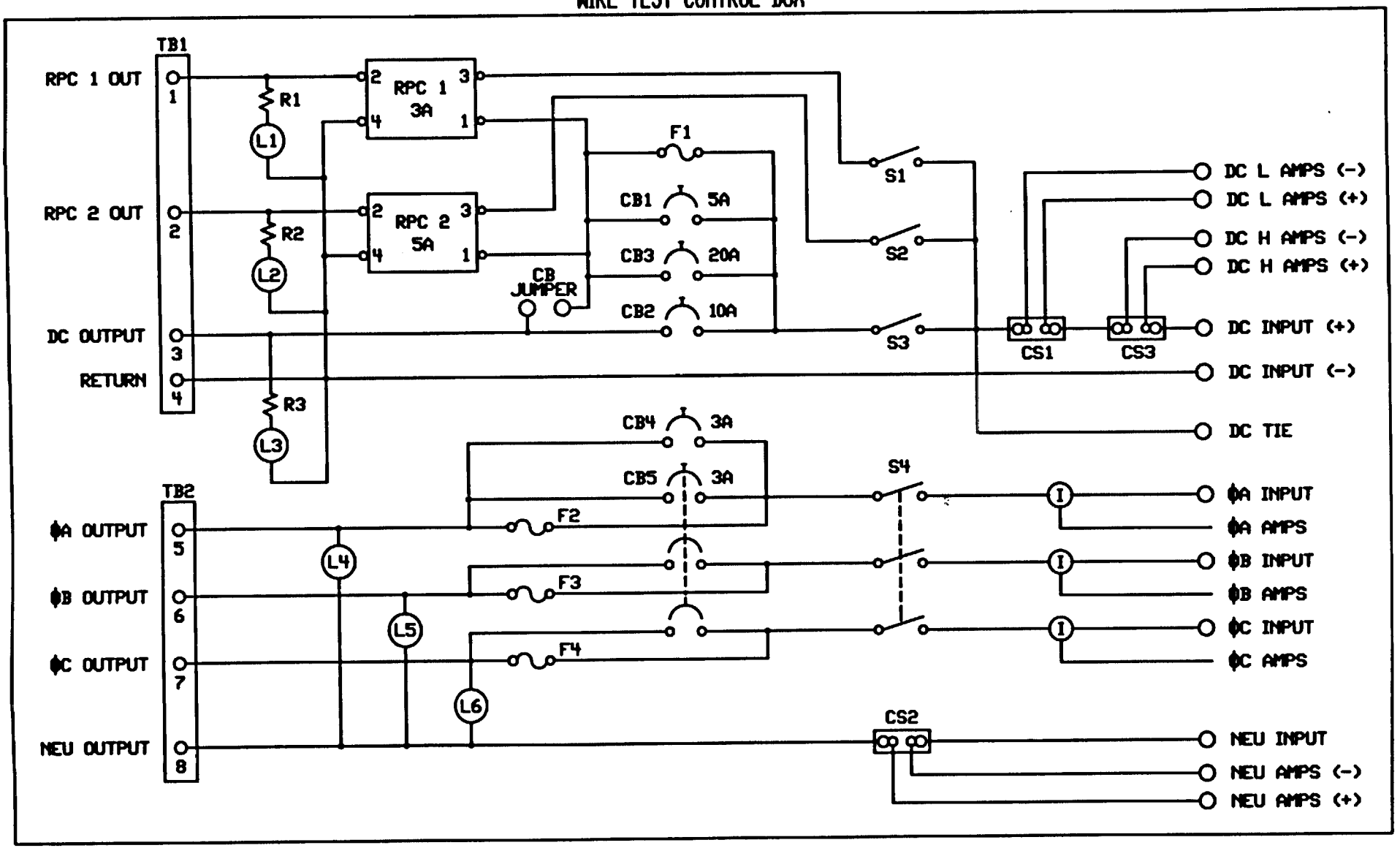
4. R1-R3 ARE 412 OHM RESISTORS.
5. L1-L6 ARE INDICATOR LAMPS.

FIGURE 1A

WIRE TEST CONTROL BOX



NOTES:

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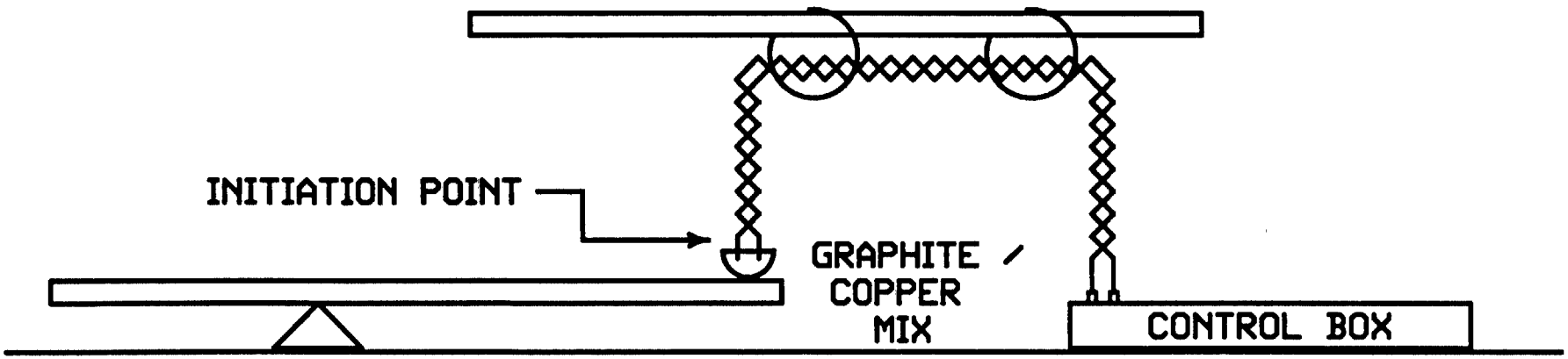
3. CS3 IS 500 AMP @ 50mV SHUNT.
4. R1-R3 ARE 412 OHM RESISTORS.
5. L1-L6 ARE INDICATOR LAMPS.

FIGURE 1B

REV C - 6/04/90

TEST SET-UP FOR TWISTED PAIR TESTING

FIGURE 2



TEST SET-UP FOR TWISTED PAIR ELECTRICAL LOADING TESTING

FIGURE 3

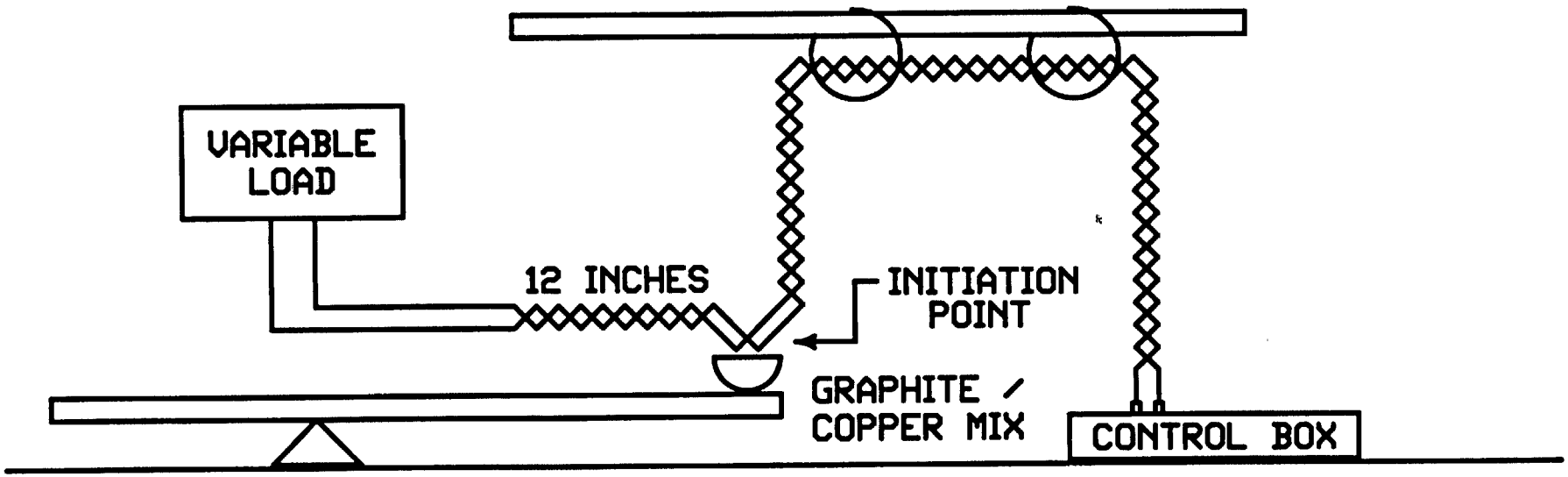
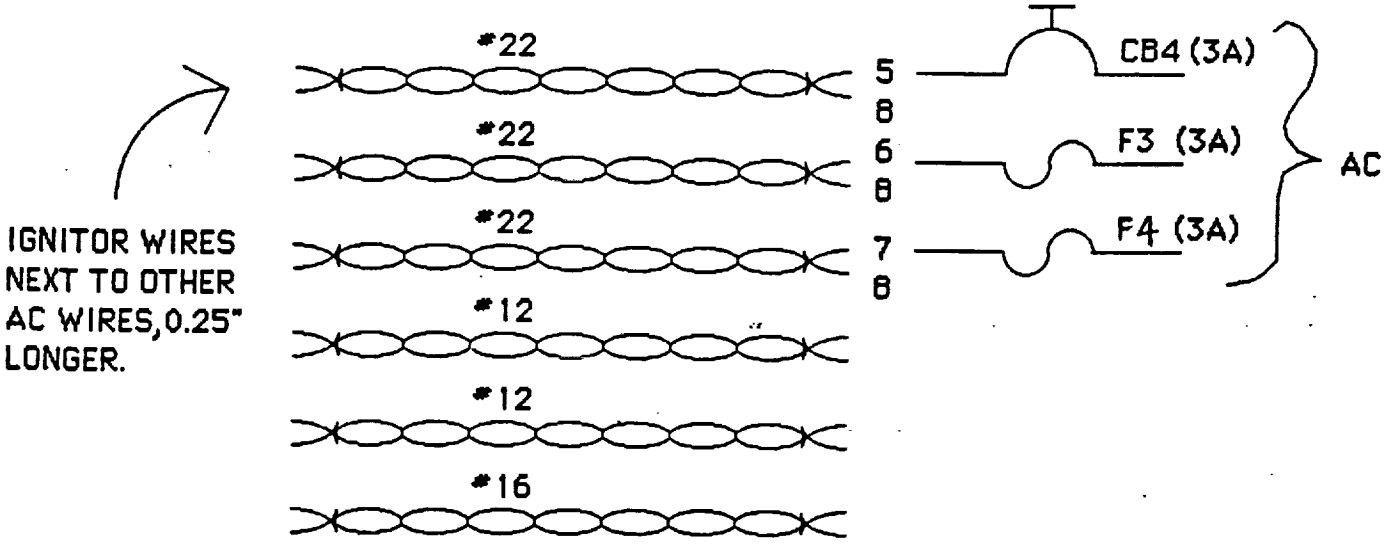


FIGURE 4

TEST VII : PART A

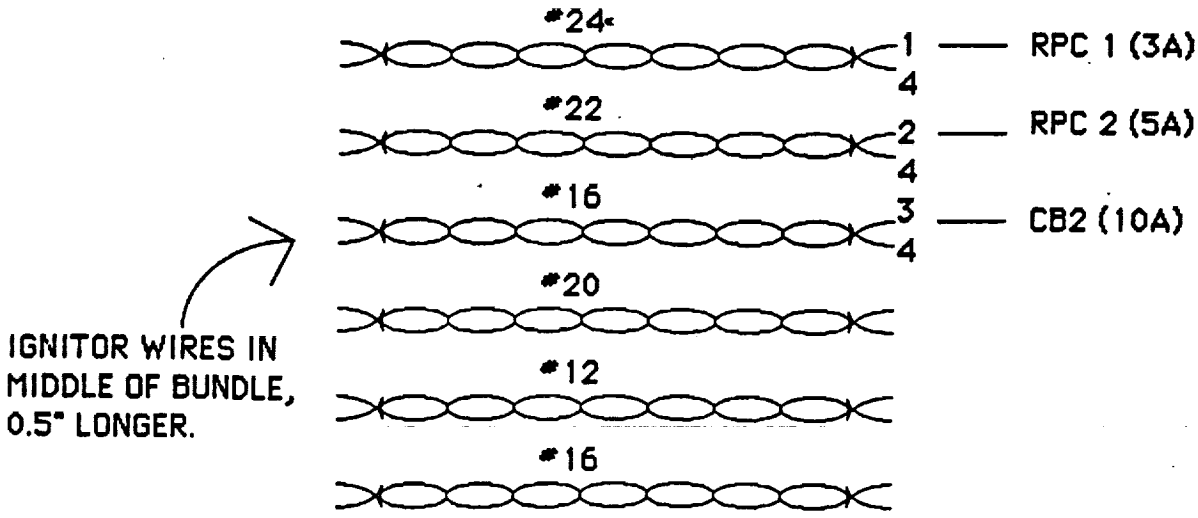
TEST AC WIRING IN A BUNDLE USING CORRECT CIRCUIT PROTECTION.



TO DETERMINE EFFECTS OF ARCING OF AC WIRES IN BUNDLES.

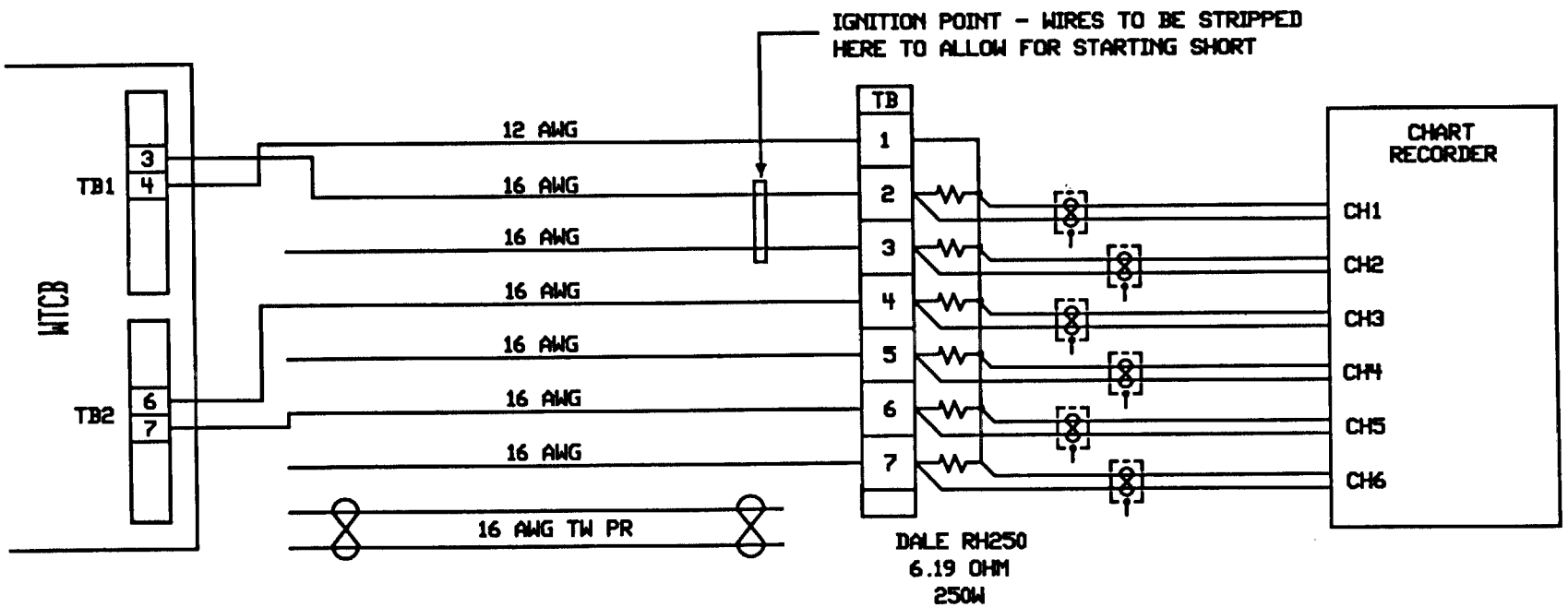
TEST VII : PART B

TEST DC WIRING IN A BUNDLE USING CORRECT CIRCUIT PROTECTION.



TO DETERMINE EFFECTS OF ARCING OF DC WIRES IN A BUNDLE.

TEST SET-UP FOR TEST IX
FIGURE 5



NOTES:

1. ALL WIRING SIZED AS SHOWN
2. WIRES TO BE FORMED INTO BUNDLE APPROXIMATELY 10' LONG

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

Test Table
Figure 6

TEST TABLE SET UP
(See Figure 6)

1) Install the plywood table top cover on the test table.

2) Install the Plexiglass protective shield on the test table.

3) Install the fume extractor.

4) Install the wire test control box.

5) Install the test sample holding jig.

6) Install the graphite/copper powder applicator. Verify approximately 0.1 inch level of powder. Powder mix should be approximately 50 percent graphite and 50 percent copper powder or granules.

7) Provide operator and viewers with face guard shields.

WIRE PREPARATION INSTRUCTIONS

1) For twisted pair wire sizes 22 and 24, add a number 20 filler wire and spot-tie the three wire bundle every 2 inches starting approximately 1/2 inch from the ignition point.

2) For twisted pair wire sizes 20 and larger, provide spot-ties every 9 inches starting approximately 1/2 inch from the ignition point.

3) For bundles with diameters of less than 1/2 inch, provide spot-ties every 2 inches.

4) For bundles with diameters 1/2 to 3 inches, provide spot-ties every 3 inches.

SHUTTLE EPDC BREADBOARD POWER-UP PROCEDURE

DC Procedure:

1. Turn on the Permit switch and the Facility Power Switch on the Source Status and Emergency Shutdown Panel of the Control Console.

2. Turn on Source Simulator Power Supply #3 by first pushing input start button and then the DC power on button. The supply should read 36 volts DC +/- 1 volt. If not, bring to desired voltage by the volts increase/decrease button.

3. Turn on the power switch on Fuel Cell Simulator (FCS) #3 top panel.

4. Push initiate switch on FCS #3 top panel to reset (down) position and hold until voltage reading on meter stabilizes.

5. Close (in) ESS 3AB and MN C circuit breakers on panel R4 of the Control Console.

6. On panel R1 of the Control Console, turn on essential bus switch 3AB-FC; verify voltage on panel meter.

7. Turn on Main DC Bus C on panel R1 of the Control Console. The flag above the switch should confirm as well as the DC display meter on the same panel.

8. Set the FCS #3 Mode Select Switch to the center (yellow) position and adjust the output deviation potentiometer to obtain a voltage of 25.45 VDC +/- 0.1 VDC at the FCS #3 output.

9. Set the FCS #3 Mode Select Switch to the Mode Int (green) position and vary the reference adjust potentiometer to obtain a voltage of 34.08 VDC +/- 0.1 VDC at FCS #3 output. Leave the switch in this position for fuel cell operation mode.

MIP__ 10. Using the Breadboard's DC Load Banks, load Main Bus C until the steady-state bus voltage is 28 +/- 4 VDC. Record the load current and the main bus voltage below.

Volts = 32 , Amps = 212

11. On panel R1 of the Control Console, turn on PRI. MN. C payload bus switch. The flag below the switch should confirm.

OPERATIONAL PROCEDURE
TEST I: WIRE SIZE DETERMINATION
PART A: DC WIRING

1. Perform test table set-up.

2. Connect monitoring equipment to the wire test control box (WTCB) as shown in figure 1.

3. Connect the DC power cable from the EPS breadboard payload bus, positive and negative, to the DC input terminals on the WTCB.

MIP__ 4. Test of Awg 24, twisted pair wire, and 28 Volts +/- 4 VDC.
Attach an Awg 24, twisted pair, test sample wire onto the jig and terminate it at pins 3 and 4 on the WTCB.

5. Verify no fuse is in fuse holder F1 on the WTCB.

6. Verify S1, S2, and S3 are open.

7. Verify CB1, CB2, and CB3 are open.

8. Perform power up procedure.

MIP__ 9. Verify 28 +/- 4 VDC at input of WTCB.

Volts = 30.25

10. Turn on fume extractor.

MIP__ 11. Test with 20 Amp CB.
Close S3 and CB3.

12. Verify light L3 is illuminated.

13. Start chart recorder.
Apply graphite powder to wire sample ends.

14. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Operator removed power with switch after 6 inches of arc track. Circuit breaker did not open.

15. Remove damaged portion of test sample in preparation for further testing.

MIP__ 16. Test with 10 Amp CB.
Open CB3, close CB2, close switch S3.

17. Verify light L3 is illuminated.

18. Start chart recorder.
Apply graphite powder to wire sample ends.

19. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Operator removed power with switch after 6 inches of arc track. Circuit breaker did not open.

20. Remove damaged portion of test sample in preparation for further testing.

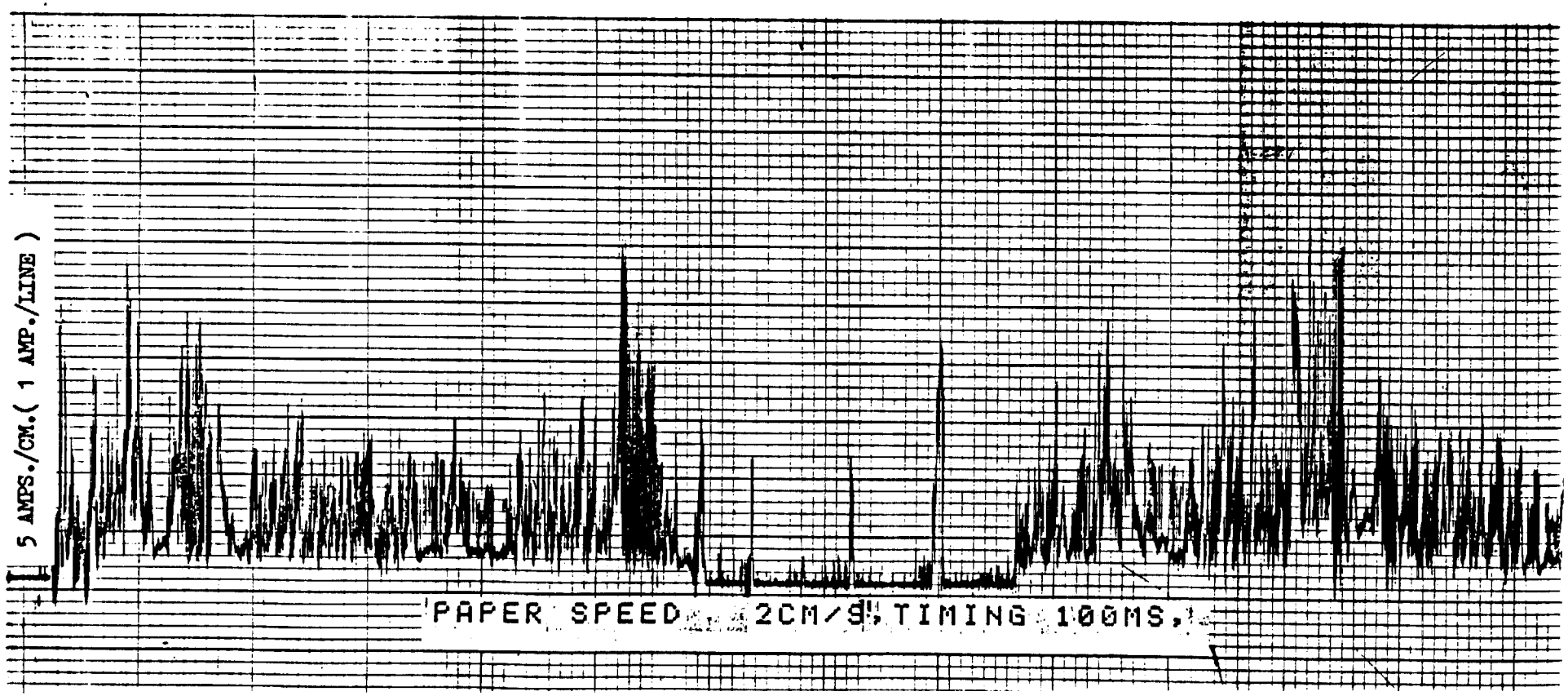
MIP__ 21. Test with 5 Amp CB.
Open CB2, close CB1, close switch S3.

22. Verify light L3 is illuminated.

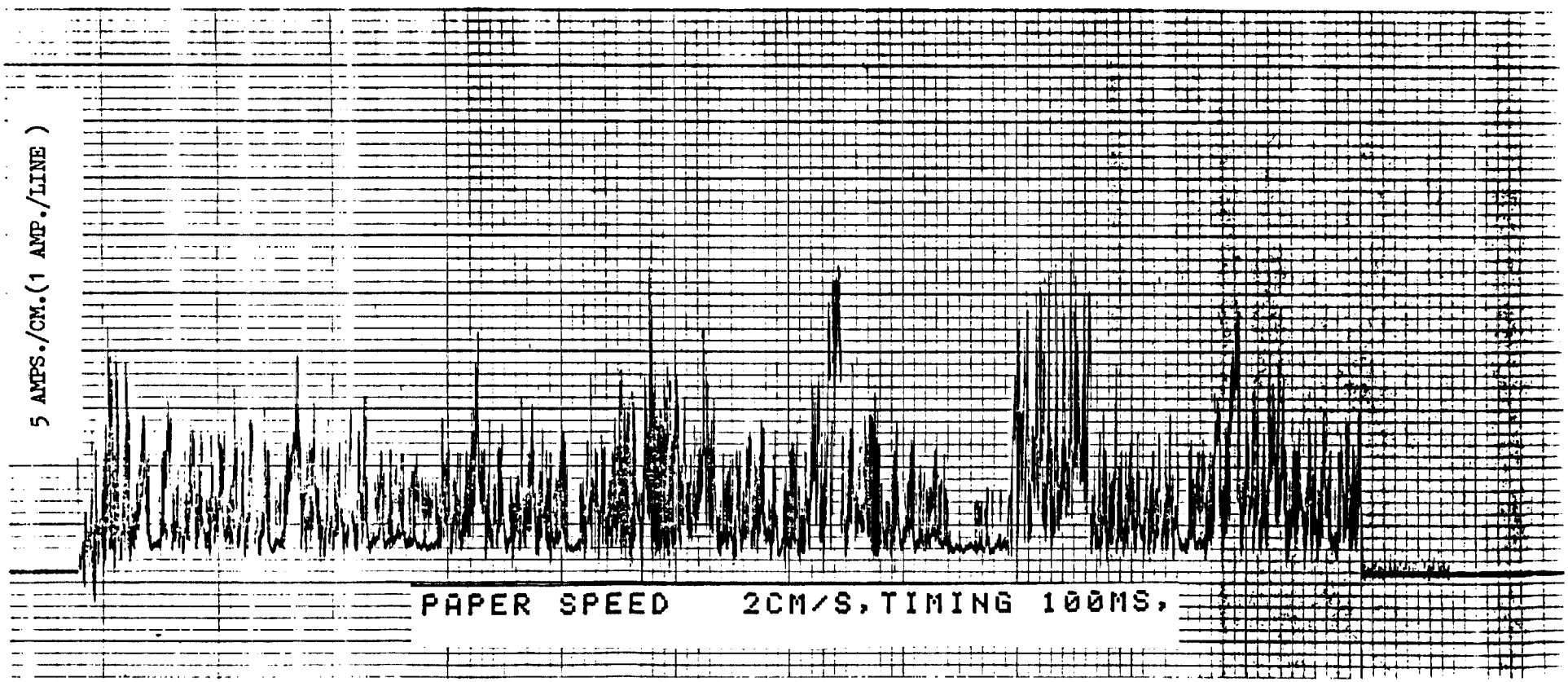
23. Start chart recorder.
Apply graphite powder to wire sample ends.

24. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop the chart recorder.

TEST I - A
STEP 16
AWG 24 TWISTED PAIR
30.5 VOLTS
10 AMP. CIRCUIT BREAKER



TEST I - A
STEP 21
AWG. 24 TWISTED PAIR
30.7 VOLTS DC
5 AMP. CIRCUIT BREAKER



MIP__ Record Results:

Operator removed power with switch after 6 inches of arc track. Circuit breaker did not open.

25. Remove damaged portion of test sample in preparation for further testing.

MIP__ 26. Test with 10 Amp fuse.
Open CB1, install a 10 amp fuse in F1. Close switch S3.

27. Verify light L3 is illuminated.

28. Start chart recorder.
Apply graphite powder to wire sample ends.

29. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Operator removed power with switch after 6 inches of arc track. Fuse did not blow.

30. Remove damaged portion of test sample in preparation for further testing.

MIP__ 31. Test with 5 Amp fuse.
Replace the fuse in F1 with a 5 amp fuse. Close switch S3.

32. Verify light L3 is illuminated.

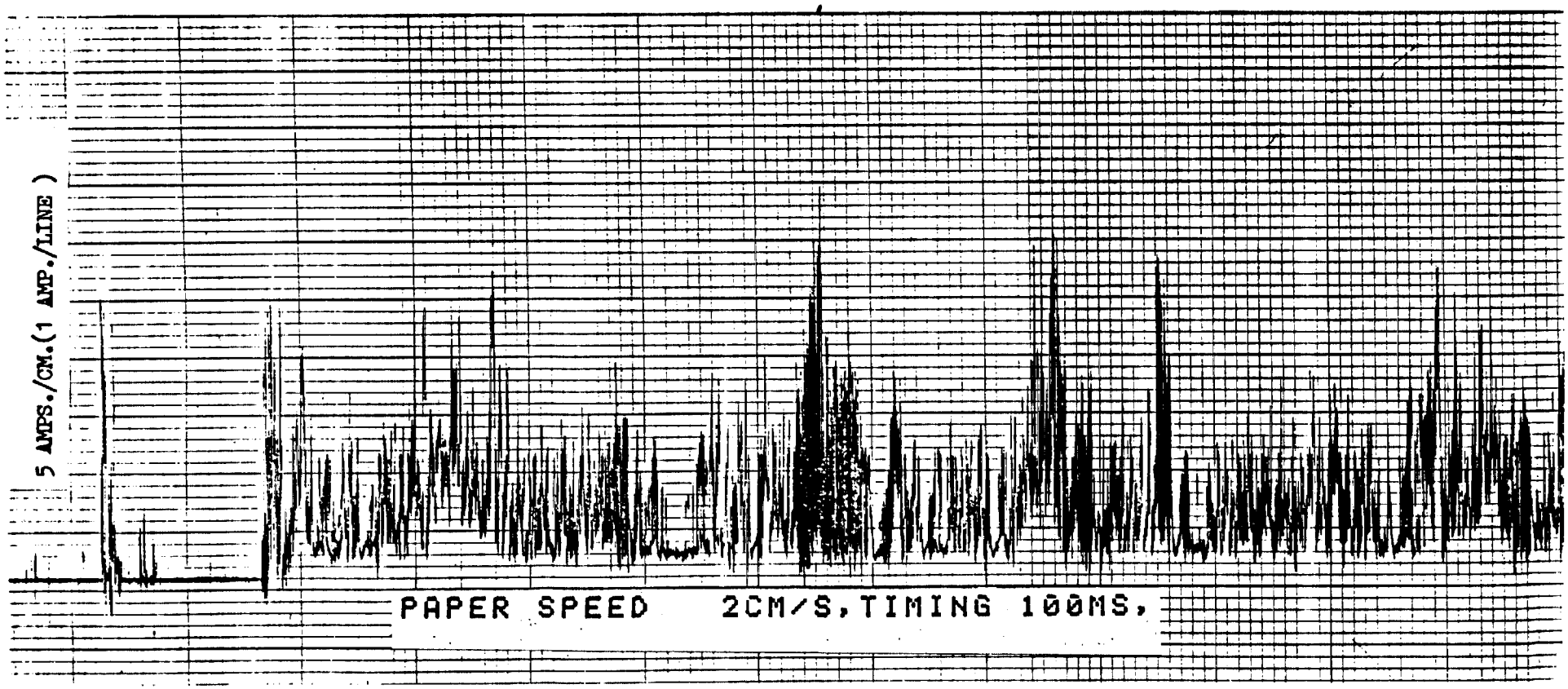
33. Start chart recorder.
Apply graphite powder to wire sample ends.

34. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

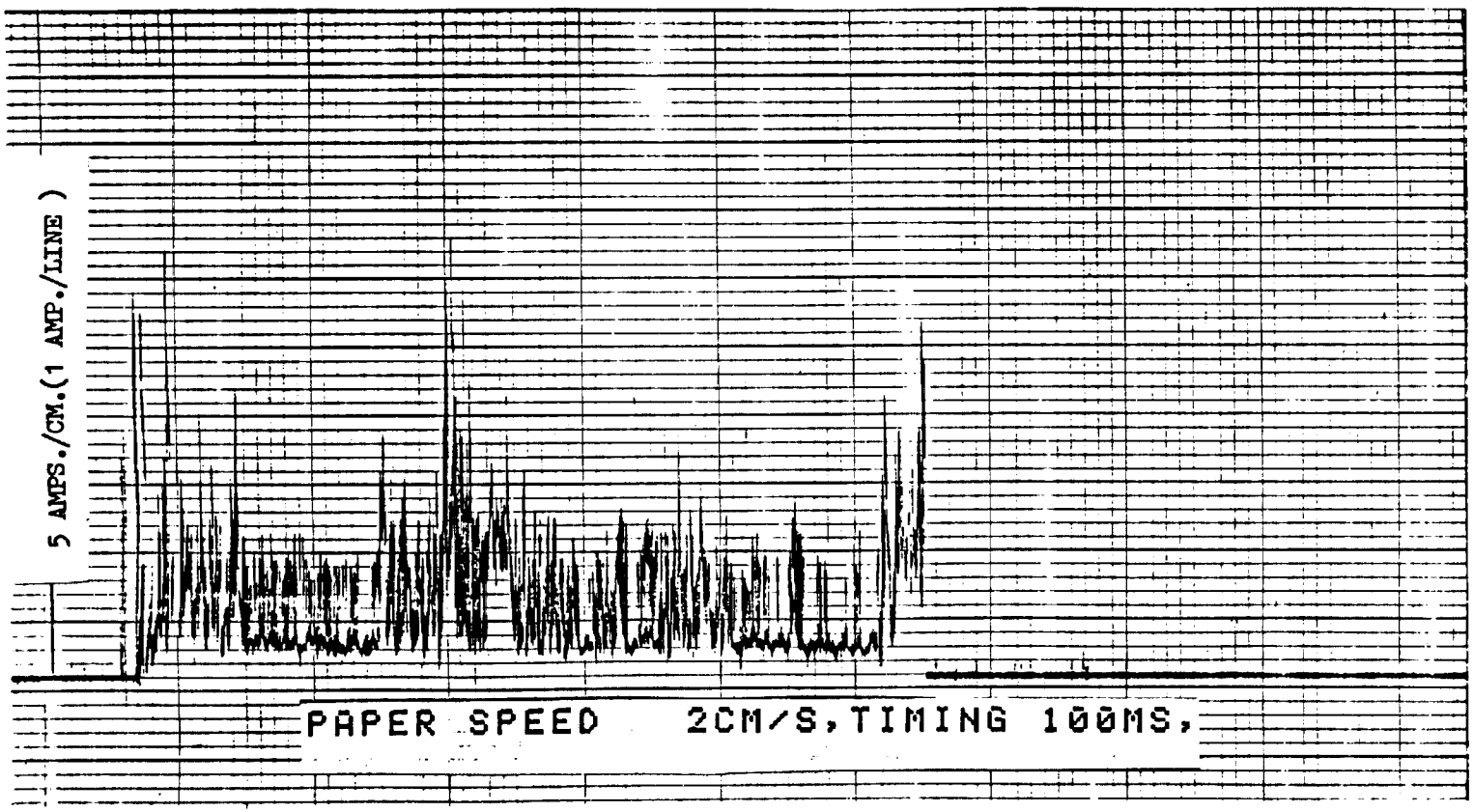
MIP__ Record Results:

Fuse blew after 2.5 inches of arc track.

TEST I- A
STEP 26
AWG. 24 TWISTED PAIR
30.7 VOLTS DC
10 AMP. FUSE



TEST I-A
STEP 31
AWG. 24 TWISTED PAIR
30.7 VOLTS DC
5 AMP. FUSE



35. Remove fuse from F1. Verify CB1, CB2, and CB3 open.

MIP__ 36. Test of Awg 10, twisted pair wire, and 28 VDC.
Remove the Awg 24 test sample from the jig and replace it with an Awg 10 test sample.

MIP__ 37. Test with 20 Amp CB.
Close S3 and CB3.

38. Verify light L3 is illuminated.

39. Start chart recorder.
Apply graphite powder to wire sample ends.

40. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opened (verified by L3 extinguished). Stop chart recorder. Open CB3.

MIP__ Record Results:

Circuit breaker opened after 0.5 inches of arc track.

MIP__ 41. If the Awg 10 wire arc tracks, replace it with an Awg 4 wire test sample. If the Awg 10 wire does not arc track, replace it with an Awg 12 wire sample.

Note: Replaced with AWG 4 wire.

MIP__ 42. Test with 20 Amp CB.
Close S3 and CB3.

43. Verify light L3 is illuminated.

44. Start chart recorder.
Apply graphite powder to wire sample ends.

45. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opened (verified by L3 extinguished). Stop chart recorder. Open CB3.

MIP__ Record Results:

Would not arc track. Terminated this test phase after several minutes of trial.

Eliminate rest of part A. Go to part B.

46. If the wire used in step 41 was size Awg 4, this terminates the DC portion of this test. Proceed to part B. If the wire used in step 41 was size Awg 12 and it arc tracked, this terminates the DC portion of this test. Proceed to part B. If the wire used in step 41 was size Awg 12 and it did not arc track, replace it with an Awg 16 wire test sample and continue.

MIP__ 47. Test with 20 Amp CB.
Close S3 and CB3.

48. Verify light L3 is illuminated.

49. Start chart recorder.
Apply graphite powder to wire sample ends.

50. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opened (verified by L3 extinguished). Stop chart recorder. Open CB3.

MIP__ Record Results:

51. If the Awg 16 wire used in step 46 arc tracked, this terminates the DC portion of this test. Proceed to part B. If the Awg 16 wire used in step 46 did not arc track, replace it with an Awg 20 wire test sample and continue.

MIP__ 52. Test with 20 Amp CB.
Close S3 and CB3.

53. Verify light L3 is illuminated.

54. Start chart recorder.
Apply graphite powder to wire sample ends.

55. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opened (verified by L3 extinguished). Stop chart recorder. Open CB3.

MIP__ Record Results:

This concludes test I, part A.

TEST I, PART B - AC WIRING

1. Connect the AC power cable from the EPS breadboard output of the inverter distribution control assembly (IDCA) #1 at the flight deck AC 1 terminal block to the AC input terminals on the WTCB.

2. Remove the test wire from terminals 3 and 4 of the WTCB and the test jig.

MIP__ 3. Test of Awg 22 wire and 117 VAC, 400 HZ, 1 phase power. Attach an Awg 22, twisted pair, test sample onto the jig and terminate it at pins 5 and 8 on the WTCB.

4. Verify no fuse in fuse holders F2, F3, and F4.

5. Verify CB4, CB5, and S4 are open.

MIP__ 6. Apply 117/208 VAC, 400Hz, to input of WTCB. Verify.

Volts = a = 118.46, b = 117.83, c = 118.07

7. Close CB4 and S4.

8. Verify light L4 is illuminated.

9. Start chart recorder.
Apply graphite powder to wire sample ends.

10. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or CB4 opened (verified by L4 extinguished). Stop chart recorder. Open CB4.

MIP__ Record Results:

Circuit breaker opened after 0.5 inches of arc track.

MIP__ 11. Test of Awg 16 wire and 117 VAC, 400 Hz, 1 phase power. Remove the Awg 22 test sample from the jig and the WTCB and replace it with an Awg 16 test sample.

12. Close S4 and CB4, verify light L4 is illuminated.

13. Start chart recorder.
Apply graphite powder to wire sample ends.

14. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or CB4 opened. Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after 0.25 inches of arc track.

MIP__ 15. Test of Awg 24, 4 wire twisted, and 117/208 VAC, 400 Hz, 3 phase power. Remove the Awg 16 test sample from the jig and the WTCB and replace it with an Awg 24, 4 wires twisted. Terminate it at pins 5, 6, 7, and 8 on the WTCB.

16. Open CB4 and close CB5.

17. Close S4, verify lights L4, L5, and L6 are illuminated.

18. Start chart recorder.
Apply graphite powder to wire sample ends.

19. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or CB5 opened (verified by L4, L5, and L6 extinguished). Stop chart recorder. Open CB5.

MIP__ Record Results:

Circuit breaker opened after 0.5 inches of arc track and burning.

MIP__ 20. Test of Awg 12, 4 wire twisted, and 117/208 VAC, 400Hz, 3 phase power. Remove the Awg 24 test sample from the jig and the WTCB and replace it with an Awg 12, 4 wire twisted sample. Close CB5.

MIP__ 21. Repeat steps 17, 18, and 19. If the size Awg 12 refuses to arc track open S4 and replace the size Awg 12 with an Awg 20, 4 wire twisted pair and repeat steps 17, 18, and 19.

MIP__ Record Results:

Circuit breaker opened after 0.125 inches of arc track.

This concludes test I, part B.

TEST II: DETERMINATION OF THE EFFECTIVENESS OF ORBITER CIRCUIT PROTECTION DEVICES.

PART A - DC WIRING

1. Perform or verify test table set-up.

2. Verify or connect monitoring equipment to the WTCB as shown in figure 1.

3. Verify no fuse in fuse holder F1.

4. Verify S1, S2, and S3 are open.

5. Verify CB1, CB2, and CB3 are open.

6. Verify or connect the DC power cable from the EPS breadboard payload bus to the DC input terminals on the WTCB.

7. Attach an Awg 24, twisted pair, test sample onto the jig and terminate it at pins 3 and 4 on the WTCB.

MIP___ 8. Test of 3 Amp fuse and Awg 24 wire (3 times). Install a 3 amp fuse in fuse holder F1.

9. Verify or perform breadboard power-up procedure.

MIP___ 10. Verify 28 +/- 4 VDC at input of WTCB.

Volts = 30.48

11. Verify or turn on fume extractor.

12. Run number 1.
Close S3. Verify L3 is illuminated.

13. Start chart recorder.
Apply graphite powder to wire sample ends.

14. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew immediately. No arc track.

15. Remove damaged portion of test sample. Replace fuse F1 if blown.

16. Run number 2.
Close S3. Verify L3 illuminated.

17. Start chart recorder.
Apply graphite powder to wire sample ends.

18. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew after less than 0.125 inches of arc track.

19. Remove damaged portion of test sample. Replace fuse F1 if blown.

20. Run number 3.
Close S3. Verify L3 is illuminated.

21. Start chart recorder.
Apply graphite powder to wire sample ends.

22. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew immediately. No arc track.

23. Remove damaged portion of test sample. Remove wire from WTCB pin 3 and move it to pin 1. Remove fuse F1.

MIP___ 24. Test of 3 Amp RPC and Awg 24 wire (3 times).
Close CB3 and S3. Verify L3 illuminated.

25. Run number 1.
Close S1. Verify L1 is illuminated.

26. Start chart recorder.
Apply graphite powder to wire sample ends.

27. Terminate this test phase by opening S1 after arcing has traveled a maximum of 6 inches or RPC 1 trips (verified by L1 extinguished). Stop chart recorder.

MIP__ Record Results:

RPC tripped after less than 0.125 inches of arc track and burn.

28. Remove damaged portion of test sample.

29. Run number 2.
Close S1. Verify L1 is illuminated.

30. Start chart recorder.
Apply graphite powder to wire sample ends.

31. Terminate this test phase by opening S1 after arcing has traveled a maximum of 6 inches or RPC 1 trips (verified by L1 extinguished). Stop chart recorder.

MIP__ Record Results:

RPC went into current limit phase immediately but operator continued to re-establish the arc. RPC tripped after less than 0.125 inches of arc track.

32. Remove damaged portion of test sample.

33. Run number 3.
Close S1. Verify L1 is illuminated.

34. Start chart recorder.
Apply graphite powder to wire sample ends.

35. Terminate this test phase by opening S1 after arcing has traveled a maximum of 6 inches or RPC 1 trips (verified by L1 extinguished). Stop chart recorder.

MIP__ Record Results:

RPC opened the circuit immediately. No arc track.

36. Remove the Awg 24 test sample from the jig and WTCB.

MIP___ 37. Test of 5 Amp RPC and Awg 22 wire (3 times). Attach an Awg 22 test sample onto the jig and terminate it at pins 2 and 4 on the WTCB.

38. Run number 1.
Close S2. Verify L2 is illuminated.

39. Start chart recorder.
Apply graphite powder to wire sample ends.

40. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC 2 trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

RPC tripped immediately. No arc track.

41. Remove damaged portion of test sample.

42. Run number 2.
Close S2. Verify L2 is illuminated.

43. Start chart recorder.
Apply graphite powder to wire sample ends.

44. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC 2 trips (verify by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

RPC tripped immediately. No arc track.

45. Remove damaged portion of test sample.

46. Run number 3.
Close S2. Verify L2 is illuminated.

47. Start chart recorder.
Apply graphite powder to wire sample ends.

48. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC 2 trips (verify by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

RPC tripped after 0.25 inches of arc track and burn.

49. Remove damaged portion of test sample.

50. Open switch S3 and CB3.

51. Remove the wire from WTCB pin 2 and move it to pin 3.

MIP___ 52. Test of 5 Amp fuse and Awg 22 wire (3 times). Install a 5 amp fuse in fuse holder F1.

53. Run number 1.
Close S3. Verify L3 is illuminated.

54. Start chart recorder.
Apply graphite powder to wire sample ends.

55. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or fuse F1 blows (verify by L3 extinguished. Stop chart recorder.

MIP__ Record Results:

Fuse blew after 2.5 inches of arc track.

56. Remove damaged portion of test sample. Replace 5 amp fuse F1 if necessary.

57. Run number 2.
Close S3. Verify L3 is illuminated.

58. Start chart recorder.
Apply graphite powder to wire sample ends.

59. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or fuse F1 blows (verify by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew after 0.5 inches of arc track.

60. Remove damaged portion of test sample. Replace 5 amp fuse F1 if necessary.

61. Run number 3.
Close S3. Verify L3 is illuminated.

62. Start chart recorder.
Apply graphite powder to wire sample ends.

63. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or fuse F1 blows (verify by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew after 0.125 inches of arc track.

64. Remove damaged portion of test sample.

MIP___ 65. Test of 5 Amp CB and Awg 22 wire (3 times).
Remove fuse from fuse holder F1. Close CB1.

66. Run number 1.
Close S3. Verify L3 is illuminated.

67. Start chart recorder.
Apply graphite powder to wire sample ends.

68. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB1 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Self extinguished after 4.5 inches of arc track.
Circuit breaker did not open.

69. Remove damaged portion of test sample. Reset CB1 if necessary.

70. Run number 2.
Close S3. Verify L3 is illuminated.

71. Start chart recorder.
Apply graphite powder to wire sample ends.

72. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB1 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after 5.0 inches of arc track.

73. Remove damaged portion of test sample. Reset CB1 if necessary.

74. Run number 3.
Close S3. Verify L3 is illuminated.

75. Start chart recorder.
Apply graphite powder to wire sample ends.

76. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB1 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after 6.0 inches of arc track.

77. Remove the Awg 22 test sample from the jig and WTCB and replace it with an Awg 20 wire test sample.

MIP___ 78. Test of 10 Amp CB and Awg 20 wire (3 times).
Open CB1 and close CB2.

79. Run number 1.
Close S3. Verify L3 is illuminated.

80. Start chart recorder.
Apply graphite powder to wire sample ends.

81. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB2 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Wires separated and opened circuit after 1.0 inch of arc track.

82. Remove damaged portion of test sample. Reset CB2 if necessary.

83. Run number 2.
Close S3. Verify L3 is illuminated.

84. Start chart recorder.
Apply graphite powder to wire sample ends.

85. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB2 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after 4.0 inches of arc track.

86. Remove damaged portion of test sample. Reset CB2 if necessary.

87. Run number 3.
Close S3. Verify L3 is illuminated.

88. Start chart recorder.
Apply graphite powder to wire sample ends.

89. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB2 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after 5.0 inches of arc track.

90. Remove damaged portion of test sample.

MIP___ 91. Test of 10 Amp fuse and Awg 20 wire (3 times).
Install a 10 amp fuse in fuse holder F1. Open CB2.

92. Run number 1.
Close S3. Verify L3 is illuminated.

93. Start chart recorder.
Apply graphite powder to wire sample ends.

94. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew after 0.5 inches of arc track.

95. Remove damaged portion of test sample. Replace 10 amp fuse F1 if necessary.

96. Run number 2.
Close S3. Verify L3 is illuminated.

97. Start chart recorder.
Apply graphite powder to wire sample ends.

98. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew after 0.25 inches of arc track.

99. Remove damaged portion of test sample. Replace 10 amp fuse F1 if necessary.

100. Run number 3.
Close S3. Verify L3 is illuminated.

101. Start chart recorder.
Apply graphite powder to wire sample ends.

102. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew after 0.25 inches of arc track.

103. Remove the test sample wire from the test jig and WTCB. Remove fuse from F1.

This concludes test II, part A.

TEST II, PART B.
AC WIRING - 1 PHASE AC POWER

1. Verify or connect the AC power cable to the AC input terminals on the WTCB.

2. Verify no fuse in fuse holders F2, F3, and F4. Verify CB4, CB5, and S4 open.

MIP__ 3. Test of Awg 22, twisted pair wire, and 3 amp CB (3 times). Attach an Awg 22, twisted pair, test sample onto the test jig and terminate it at pins 5 and 8 on the WTCB.

4. Apply 117/208 VAC, 400 Hz, to input of WTCB.
   Volts = 118.55

5. Run number 1.
   Close CB4.

6. Close S4, verify L4 is illuminated.

7. Start chart recorder.
   Apply graphite powder to wire sample ends.

8. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

   Circuit breaker opened after 0.5 inches of arc track.

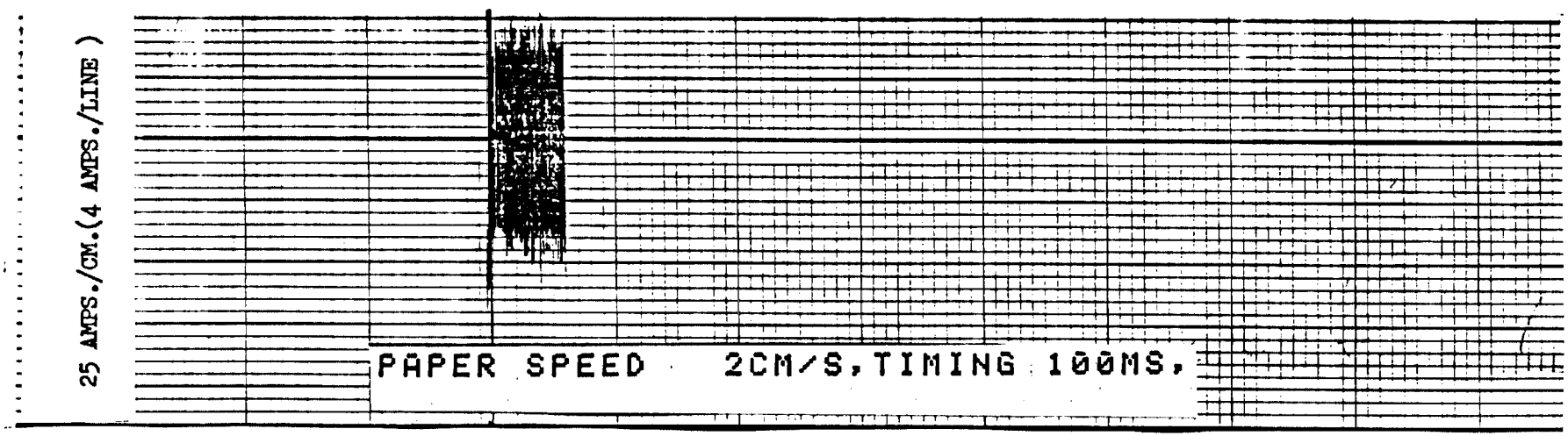
9. Remove damaged portion of test sample. Reset CB4 if necessary.

10. Run number 2.
    Close S4, verify L4 is illuminated.

11. Start chart recorder.
    Apply graphite powder to wire sample ends.

12. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L4 extinguished). Stop chart recorder.

TEST II - B
STEP 10
AWG 22 TWISTED PAIR
118 VOLTS AC
3 AMP. CIRCUIT BREAKER



MIP__ Record Results:

Circuit breaker opened after 0.5 inch of arc track.

13. Remove damaged portion of test sample. Reset CB4 if necessary.

14. Run number 3.
Close S4, verify L4 is illuminated.

15. Start chart recorder.
Apply graphite powder to wire sample ends.

16. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after 0.5 inches of arc track. Violent and smoky reaction.

17. Remove damaged portion of test sample. Open CB4.

MIP__ 18. Test of Awg 22, twisted pair wire, and 3 amp fuse (3 times).
Install a 3 amp fuse in fuse holder F2.

19. Run number 1.
Close S4, verify L4 is illuminated.

20. Start chart recorder.
Apply graphite powder to wire sample ends.

21. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew immediately. No arc track.

22. Remove damaged portion of test sample. Replace fuse F2 if necessary.

23. Run number 2.
Close S4, verify L4 is illuminated.

24. Start chart recorder.
Apply graphite powder to wire sample ends.

25. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew immediately. No arc track.

26. Remove damaged portion of test sample. Replace fuse F2 if necessary.

27. Run number 3.
Close S4, verify L4 is illuminated.

28. Start chart recorder.
Apply graphite powder to wire sample ends.

29. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew immediately. No arc track.

30. Remove damaged portion of test sample.

MIP__ 31. Test of Awg 22, twisted pair wire, and 0.5 amp fuse (3 times). Remove fuse from F2 and replace with a 0.5 amp fuse.

32. Run number 1.
Close S4, verify L4 is illuminated.

33. Start chart recorder.
Apply graphite powder to wire sample ends.

34. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew immediately. No arc track.

35. Remove damaged portion of test sample. Replace fuse F2 if necessary.

36. Run number 2.
Close S4, verify L4 is illuminated.

37. Start chart recorder.
Apply graphite powder to wire sample ends.

38. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew immediately. No arc track.

39. Remove damaged portion of test sample. Replace fuse F2 if necessary.

40. Run number 3.
Close S4, verify L4 is illuminated.

41. Start chart recorder.
Apply graphite powder to wire sample ends.

42. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

Fuse blew immediately. No arc track.

43. Remove test sample from jig and WTCB. Remove fuse from F2 fuse holder.

This concludes test II, part B.

TEST II, PART C
AC WIRING - 3 PHASE AC POWER

MIP__ 1. Test of Awg 22, 4 wire twisted, and 3 Amp CB (3 times).
Attach an Awg 22, 4 wire twisted, test sample onto the test jig and terminate it at pins 5, 6, 7, and 8 on the WTCB.

MIP__ 2. Verify or apply 117/208 VAC, 400 Hz, to input of WTCB.

Volts = a = 118.59, b = 118.07, c = 118.93

3. Verify CB4 open.

4. Close CB5.

5. Run number 1.
Close S4, verify L4, L5 and L6 are illuminated.

6. Start chart recorder.
Apply graphite powder to wire sample ends.

7. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verify by L4, L5, and L6 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after less than 0.5 inches of arc track.

8. Remove damaged portion of test sample. Reset CB5 if necessary.

9. Run number 2.
Close S4, verify L4, L5 and L6 are illuminated.

10. Start chart recorder.
Apply graphite powder to wire sample ends.

11. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verify by L4, L5, and L6 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after 0.5 inches of arc track.

12. Remove damaged portion of test sample. Reset CB5 if necessary.

13. Run number 3.
Close S4, verify L4, L5 and L6 are illuminated.

14. Start chart recorder.
Apply graphite powder to wire sample ends.

15. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verify by L4, L5, and L6 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after 0.5 inches of arc track.

16. Remove damage portion of test sample. Open CB5.

MIP__ 17. Test of Awg 22, 4 wire twisted, and 3 Amp fuse (3 times).
Install 3 amp fuses in fuse holders F2, F3, and F4.

18. Run number 1.
Close S4, verify L4, L5, and L6 are illuminated.

19. Start chart recorder.
Apply graphite powder to wire sample ends.

20. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device(s) has (have) opened the circuit (verify by L4, L5, and L6 extinguished). Stop chart recorder.

MIP__ Record Results:

All fuses blew almost immediately. Less than 0.125 inches of arc track.

21. Remove damaged portion of test sample. Replace fuses in F2, F3, and F4 if necessary.

22. Run number 2.
Close S4, verify L4, L5, and L6 are illuminated.

23. Start chart recorder.
Apply graphite powder to wire sample ends.

24. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device(s) has (have) opened the circuit (verify by L4, L5, and L6 extinguished). Stop chart recorder.

MIP__ Record Results:

All fuses blew immediately.

25. Remove damaged portion of test sample. Replace fuses in F2, F3, and F4 if necessary.

26. Run number 3.
Close S4, verify L4, L5, and L6 are illuminated.

27. Start chart recorder.
Apply graphite powder to wire sample ends.

28. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device(s) has (have) opened the circuit (verify by L4, L5, and L6 extinguished). Stop chart recorder.

MIP__ Record Results:

All fuses blew immediately.

MIP__ 29. Test of Awg 22, 4 wire twisted, and 0.5 Amp fuse (3 times).
Remove fuses from F2, F3, and F4 and replace with 0.5 Amp fuses.

ELIMINATED THE REST OF TEST II BECAUSE IT WAS DEEMED UNNECESSARY.....

30. Run number 1.
Close S4, verify L4, L5, and L6 are illuminated.

31. Start chart recorder.
Apply graphite powder to wire sample ends.

32. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device(s) has (have) opened the circuit (verify by L4, L5, and L6 extinguished). Stop chart recorder.

MIP__ Record Results:

NOT PERFORMED.

33. Remove damaged portion of test sample. Replace fuses in F2, F3, and F4 if necessary.

34. Run number 2.
Close S4, verify L4, L5, and L6 are illuminated.

35. Start chart recorder.
Apply graphite powder to wire sample ends.

36. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device(s) has (have) opened the circuit (verify by L4, L5, and L6 extinguished). Stop chart recorder.

MIP__ Record Results:

NOT PERFORMED.

37. Remove damaged portion of test sample. Replace fuses in F2, F3, and F4 if necessary.

38. Run number 3.
Close S4, verify L4, L5, and L6 are illuminated.

39. Start chart recorder.
Apply graphite powder to wire sample ends.

40. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device(s) has (have) opened the circuit (verify by L4, L5, and L6 extinguished). Stop chart recorder.

MIP__ Record Results:

NOT PERFORMED.

41. Remove test sample from jig and WTCB. Remove fuses from F2, F3, and F4.

This concludes test II, part C.

TEST III - DETERMINATION OF THE EFFECTS OF SINGLE POWER WIRES ARCING TO STRUCTURE.

MIP__ A. TEST SAMPLE NUMBER 1 (3 times)

1. Lace together 6 number Awg 22 wires 3 feet in length with 1 number Awg 22 test sample 10 feet in length facing the out side and extending 1 inch beyond other wires. Do not twist wires.

2. Place bundle with test sample down onto a metal plate.

3. Attach test sample end to pin 3 of the WTCB and attach a wire from the metal plate to pin 4 of the WTCB.

MIP__ 4. Connect, or verify, the DC power cable to the WTCB. Apply 28 +/- 4 VDC.

Volts = 30.49

5. Close CB3.

6. Run number 1.
Close S3. Verify L3 is illuminated.

7. Start chart recorder.
Apply graphite powder to test wire and plate.

8. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). If arcing is not sustainable, terminate this test phase after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arcing took place only when the wire was pressed to the plate. There was no arc tracking.

9. If arcing was sustainable in step 8, remove damaged portion of test sample and continue.

10. Run number 2.
Reset CB3 if necessary. Close S3. Verify L3 is illuminated.

11. Start chart recorder.
Apply graphite powder to test sample and plate.

12. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). If arcing is not sustainable, terminate this test phase after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arcing took place only when the wire was pressed to the plate. There was no arc tracking.

13. Remove damaged portion of test sample.

14. Run number 3.
Reset CB3 if necessary. Close S3. Verify L3 is illuminated.

15. Start chart recorder.
Apply graphite powder to test sample and plate.

16. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished) If arcing is not sustainable terminate this test phase after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

This run was cancelled because it was deemed unnecessary.

MIP__ B. TEST SAMPLE NUMBER 2 (3 times)

1. With test sample and wires grouped as in part A, ground the wire next to the test sample to pin 4 of the WTCB in addition to the metal plate.

2. Place the bundle with test sample down onto the metal plate.

3. Verify or close CB3.

4. Run number 1.
Close S3. Verify L3 is illuminated.

5. Start chart recorder.
Apply graphite powder to test wire and plate.

6. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished) If arcing is not sustainable, terminate this test phase after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arcing took place only when the wire was pressed to the plate. There was no arc tracking.

7. If arcing was sustainable in step 6, remove damaged wire(s), reconfigure for testing, and continue.

8. Run number 2.
Reset CB3 if necessary. Close S3. Verify L3 is illuminated.

9. Start chart recorder.
Apply graphite powder to test sample and plate.

10. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). If arcing is not sustainable, terminate this test phase after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arcing took place only when the wire was pressed to the plate. There was no arc tracking.

11. Remove damaged wire(s) and reconfigure for testing.

12. Run number 3.
Reset CB3 if necessary. Close S3. Verify L3 illuminated.

13. Start chart recorder.
Apply graphite powder to test sample and plate.

14. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). If arcing is not sustainable, terminate this test phase after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

This run was cancelled because it was deemed unnecessary.

This concludes test III, part B.

TEST IV: DETERMINATION OF THE EFFECTS OF ELECTRICAL LOADING ON THE ARC TRACKING OF WIRES.

MIP__ PART A: ARC TRACKING TESTING WHILE WIRES ARE CARRYING 1 AMPERE (3 TIMES).

1. Connect the DC power cable to the WTCB.

2. Verify all circuit breakers and switches on the WTCB are in open position.

3. Verify or perform power up procedure.

4. Connect a 10 ft. section of Awg 20 twisted pair to pins 3 and 4 of WTCB.

MIP__ 5. Attach a 30 watt (1 Amp.) load to the other end of the wires.

Amp = 1.08 amperes

6. Twelve inches from the load wire attachment point, remove a 1/4 inch of insulation from both test sample wires. See figure 3.

7. Verify fume extractor on.

8. Close CB2.

9. Run number 1.
Close S3. Verify L3 is illuminated.

10. Start chart recorder.
Apply graphite powder to bared wires of test sample.

11. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened after 0.25 inches of arc track.

12. Remove damaged portion of test sample. Reconfigure with wires bared at point of arc initiation.

13. Reset CB2 if necessary.

14. Run number 2.
    Close S3. Verify L3 is illuminated.

15. Start chart recorder.
    Apply graphite powder to bared wires of test sample.

16. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Wire burned open and removed power from the circuit after 0.5 inches of arc track.

17. Remove damaged portion of test sample. Reconfigure with wires bared at point of arc initiation.

18. Reset CB2 if necessary.

19. Run number 3.
    Close S3. Verify L3 is illuminated.

20. Start chart recorder.
    Apply graphite powder to bared wires of test sample.

21. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Circuit breaker opened almost immediately. No arc track.

22. Remove damaged portion of test sample. Reconfigure with wires bared at point of arc initiation. If wires are deemed too short for further testing, replace with new 10 ft. section with wires readied for test.

MIP__ PART B: ARC TRACK TESTING WHILE WIRES ARE CARRYING 3 AMPERES (3 times)

MIP __ 1. Remove the 30 watt (1 amp) load and replace it with a 90 watt (3 amp) load.

Amp = 3.08 amperes

2. Verify CB2 closed.

3. Run number 1.
Close S3. Verify L3 is illuminated.

4. Start chart recorder.
Apply graphite powder to bared wires of test sample.

5. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

After about 0.5 inches of arc tracking and burning, the wires fused together causing the circuit breaker to open.

6. Remove damaged portion of test sample. Reconfigure with wires bared at point of arc initiation.

7. Reset CB2 if necessary.

8. Run number 2.
Close S3. Verify L3 is illuminated.

9. Start chart recorder.
Apply graphite powder to bared wires of test sample.

10. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

After about 1.5 inches of arc tracking the wires to the load burned open and the circuit breaker opened.

11. Remove damaged portion of test sample. Reconfigure with wires bared at point of arc initiation.

12. Reset CB2 if necessary.

13. Run number 3.
Close S3. Verify L3 is illuminated.

14. Start chart recorder.
Apply graphite powder to bared wires of test sample.

15. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 6.0 inches of arc track. The wires to the load had burned in two.

16. Open CB2.

17. Remove wire and load from jig and WTCB.

This concludes test IV.

TEST V: DETERMINATION OF THE EFFECTS OF INSTALLATION HARDWARE (3 TIMES).
For this testing use Awg 22 twisted pair wire, 28 +/- 4 VDC and a 20 amp breaker.

MIP ___ Volts = 30.53

PART A. In-line splice.

MIP ___ 1. Select a 10 ft. sample of Awg 22 twisted pair wire. Connect one end to pins 3 and 4 of the WTCB. At the other end of the wire pair, slide a 1 inch piece of Teflon heat shrinkable tubing onto one of the wires to approximately 2 inches from the end. Heat shrink the tubing.

STANDARD SPLICES WERE USED IN LIEU OF THE TUBING NOTED IN THE PROCEDURE.

2. Verify test readiness. DC power at WTCB input. Fume extractor on.

3. Close CB3.

4. Run number 1.
Close S3. Verify L3 is illuminated.

5. Start chart recorder.
Apply graphite powder to wire sample ends.

6. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or arcing has ceased due to Teflon sleeve barrier, or CB3 opened (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

After 0.5 inches of arc track the wires separated and opened the circuit.

7. Remove damaged portion of test sample. Prepare new sample. Slide a 1 inch piece of Teflon heat shrinkable tubing onto one of the wires to approximately 2 inches from the end. Heat shrink the tubing.

8. Close CB3 if necessary.

9. Run number 2.
Close S3. Verify L3 is illuminated.

10. Start chart recorder.
Apply graphite powder to wire sample ends.

11. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or arcing has ceased due to Teflon sleeve barrier, or CB3 opened (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

After 0.5 inches of arc track the wires separated and opened the circuit.

12. Remove damaged portion of test sample. Prepare new sample. Slide a 1 inch piece of Teflon heat shrinkable tubing onto one of the wires to approximately 2 inches from the end. Heat shrink the tubing.

13. Close CB3 if necessary.

14. Run number 3.
Close S3. Verify L3 is illuminated.

15. Start chart recorder.
Apply graphite powder to wire sample ends.

16. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or arcing has ceased due to Teflon sleeve barrier, or CB3 opened (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

After 0.5 inches of arc track the wires separated and opened the circuit.

17. Remove the wire test sample from the jig and WTCB.

PART B. In-line bundle spot-ties.

MIP___ 1. Prepare a 10 foot long wire bundle with the following size wires, 2 #12 gage, 2 #16 gage, and 1 twisted pair #22 gage test sample. Spot-tie this bundle every 2 inches. Attach one end of the number 22 gage test sample wires to the WTCB at pins 3 and 4, allow the other end (ignition end) of the test sample wires to extend 0.5 inches beyond the other wires in the bundle.

2. Verify or close CB3.

3. Run number 1.
   Close S3. Verify L3 is illuminated.

4. Start chart recorder.
   Apply graphite powder to the number 22, test sample ends.

5. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or arcing has ceased, or CB3 opened (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The operator opened the circuit after 6.0 inches of arc track.

6. Remove damaged portion of wiring. Prepare end of wires for further testing.

7. Verify or close CB3.

8. Run number 2.
   Close S3. Verify L3 is illuminated.

9. Start chart recorder.
   Apply graphite powder to test sample ends.

10. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or arcing has ceased, or CB3 opened (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

After 5.5 inches of arc track the wires burned in two and opened the circuit.

11. Remove damaged portion of wiring. Prepare end of wires for further testing.

12. Verify or close CB3.

13. Run number 3.
    Close S3. Verify L3 is illuminated.

14. Start chart recorder.
    Apply graphite powder to test sample ends.

15. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or arcing has ceased, or CB3 opened (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The operator opened the circuit after 6.0 inches of arc track.

16. Remove damaged portion of wiring. Prepare end of wires for further testing.

PART C. In-line bundle clamp.

MIP __ 1. Attach a one hole mounting type cushioned clamp around the bundle, 2 inches from ignition end of the bundle. If necessary use a support rod or insulated wire segments for filler.

2. Verify or close CB3.

3. Run number 1.
Close S3. Verify L3 is illuminated.

4. Start chart recorder.
Apply graphite powder to test sample ends.

5. Terminate this test phase by opening S3 after arcing has traveled 6 inches, or arcing has ceased, or CB3 opened verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Arc tracked through the clamp for a distance of 5.0 inches. The wire burned in two and opened the circuit.

6. Remove damaged portion of wiring. Reconfigure wires for further testing.

7. Verify or close CB3.

8. Run number 2.
Close S3. Verify L3 is illuminated.

9. Start chart recorder.
Apply graphite powder to test sample ends.

10. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or arcing has ceased, or CB3 opened verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

Arc tracked into the clamp and extinguished. Periodic sparks were visible for about 10 seconds.

11. Remove damaged portion of wiring. Reconfigure wires for further testing.

12. Verify or close CB3.

13. Run number 3.
Close S3. Verify L3 is illuminated.

14. Start chart recorder.
Apply graphite powder to test sample ends.

15. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or arcing has ceased, or CB3 opened verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

On the first try the arc tracked into the bundle and extinguished. On the second try the arc tracked through the clamp for a distance of 6.0 inches and the operator opened the circuit.

16. Remove test wiring from jig and WTCB.

This concludes test V.

TEST VI: DETERMINATION OF THE EFFECTS OF DC VOLTAGE LEVELS ON ARC TRACKING.

MIP__ PART A: Testing with Awg 22 twisted pair wires and applied voltage of 15 VDC (3 times).

1. Connect a power cable from a voltage adjustable DC source (portable power supply of 20 amperes capability or higher) to the DC input terminals on the WTCB.

Used H.P. 6012 A Ser. 19468 - 00122

2. Attach an Awg 22, twisted pair, test sample wire onto the jig and terminate it at pins 3 and 4 on the WTCB.

3. Verify S1, S2, S3, CB1, CB2, and CB3 open.

MIP__ 4. Provide 15 volts DC to input of WTCB.

Volts = 15.01.

5. Run number 1.
Close S3 and CB2. Verify L3 is illuminated.

6. Start chart recorder.
Apply graphite powder to wire sample ends.

7. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened (verified by L3 extinguished), or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arcing was difficult to start, but after it did the circuit breaker opened the circuit after 3.0 inches of arc track.

8. Remove damaged portion of test sample and continue.

9. Close CB2 if open.

10. Run number 2.
Close S3. Verify L3 is illuminated.

11. Start chart recorder.
Apply graphite powder to wire sample ends.

12. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened (verified by L3 extinguished), or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Again arcing was difficult to start but after it did, it arc tracked and flamed for a distance of 6.0 inches and the operator opened the circuit.

13. Remove damaged portion of test sample and continue.

14. Close CB2 if open.

15. Run number 3.
Close S3. Verify L3 illuminated.

16. Start chart recorder.
Apply graphite powder to wire sample ends.

17. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened (verified by L3 extinguished), or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

There was some slight sparking but no sustainable arc track. This test was terminated after a five minute trial period.

18. Remove the Awg 22 wire from the jig and WTCB.

MIP__ PART B: Testing with Awg 24 twisted, shielded pair wires, and reduced voltages (3 times).

1. Attach and Awg 24 twisted, shielded pair, test sample onto the jig and terminate it at pins 3 and 4 on the WTCB. Terminate the shield at pin 4. At the ignition end of the wire remove 1 inch of the shield.

MIP___ 2. Adjust the WTCB input voltage to 5 VDC.

Volts = 5.03

3. Close CB2 if open.

MIP___ 4. Run number 1.
Close S3. Verify voltage at pin 3 of WTCB.

Volts = 5.03

5. Start chart recorder.
Apply graphite powder to wire sample ends.

6. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened, or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arc tracking would not occur. The wire ends glowed and the current was about 8.0 amperes. The test was terminated after five minutes of trial.

7. Remove damaged portion of test wire and reconfigure for continued testing.

8. Close CB2 if open.

MIP ___ 9. Run number 2.
Close S3. Verify voltage at pin 3 of WTCB.

Volts = 5.03

10. Start chart recorder.
Apply graphite powder to wire sample ends.

11. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened, or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arc tracking would not occur. The test was terminated after two minutes of trial.

12. Remove damaged portion of test wire and reconfigure for continued testing.

13. Close CB2 if open.

MIP ___ 14. Run number 3.
Close S3. Verify voltage at pin 3 of WTCB.

Volts = 5.0

15. Start chart recorder.
Apply graphite powder to wire sample ends.

16. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened, or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arc tracking would not occur. The test was terminated after two minutes of trial.

17. Remove damaged portion of test wire and reconfigure for continued testing.

MIP___ 18. Adjust the WTCB input voltage to 15 VDC.

Volts = 15.02.

19. Close CB2 if open.

20. Run number 1.
Close S3. Verify L3 is illuminated.

21. Start chart recorder.
Apply graphite powder to wire sample ends.

22. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened, or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

The wire fused. The current was steady at about 15.0 amperes. The circuit breaker did not open. Arc tracking did not occur. The operator opened the circuit after three minutes.

23. Remove damaged portion of test wire and reconfigure for continued testing.

24. Close CB2 if open.

25. Run number 2.
Close S3. Verify L3 is illuminated.

26. Start chart recorder.
Apply graphite powder to wire sample ends.

27. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened, or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened the circuit after 3.5 inches of arc tracking. The shield burned, as well as the wires.

28. Remove damaged portion of test wire and reconfigure for continued testing.

29. Close CB2 if open.

30. Run number 3.
Close S3. Verify L3 is illuminated.

31. Start chart recorder.
Apply graphite powder to wire sample ends.

32. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened, or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened the circuit after 2.5 inches of arc tracking.

33. Remove damaged portion of test wire and reconfigure for continued testing.

MIP__ 34. Adjust the WTCB input voltage to 28 VDC.
Used the fuel cell simulator.
Volts = 30.31

35. Close CB2 if open.

36. Run number 1.
Close S3. Verify L3 is illuminated.

37. Start chart recorder.
Apply graphite powder to wire sample ends.

38. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened, or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arc tracked readily. After 6.0 inches of arc track the operator opened the circuit.

39. Remove damaged portion of test wire and reconfigure for continued testing.

40. Close CB2 if open.

41. Run number 2.
Close S3. Verify L3 is illuminated.

42. Start chart recorder.
Apply graphite powder to wire sample ends.

43. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened, or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arc tracked readily. After 6.0 inches of arc track the operator opened the circuit.

44. Remove damaged portion of test wire and reconfigure for continued testing.

45. Close CB2 if open.

46. Run number 3.
Close S3. Verify L3 is illuminated.

47. Start chart recorder.
Apply graphite powder to wire sample ends.

48. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches, or CB2 opened, or after a 5 minute trial period. Stop chart recorder.

MIP__ Record Results:

Arc tracked readily. After 6.0 inches of arc track the operator opened the circuit.

49. Turn off DC power supply.

50. Open CB2.

51. Remove test sample from the jig and WTCB.

This concludes test VI.

TEST VII: DETERMINE THE EFFECTS OF BUNDLING ON PROPAGATION.
PART A: TEST OF JSC PREPARED BUNDLE CARRYING AC POWER (6 PAIR BUNDLE WITH THREE PAIR POWERED).

MIP__ 1. Verify test readiness with AC power per previous facility set up instructions. Prepare a 10 foot long wire bundle with the following orbiter type wires: 3 twisted pairs Awg #22, 2 twisted pairs Awg #12, and 1 twisted pair Awg #16. Spot-tie this bundle every 2 inches. Terminate one wire of a Awg #22 pair to pin 5 (3 Amp CB) on the WTCB and the other wire to pin 8. Terminate one wire of the second Awg #22 pair to pin 6 (3 Amp fuse) and the other wire to pin 8. Terminate one wire of the third Awg #22 pair to pin 7 (3 Amp fuse) and the other wire to pin 8. The wire pair attached to pins 5 and 8 will be the initiator wires. Allow these initiator wires to extend 0.25 inches beyond the other wires. Separate the other powered wire ends.

2. Verify S4 open. Install 3 Amp fuses in F3 and F4. Close CB4.

3. Verify or apply 117/208 VAC, 400 Hz, to the input of WTCB.

MIP__ PHA VOLTS = 118.0 PHB VOLTS = 117.6 PHC VOLTS = 118.4

Run number 1.

4. Close S4. Verify that L4, L5, and L6 are illuminated.

5. Start chart recorder. Apply graphite powder to wire sample ends.

6. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verify L4, L5, and L6). Stop the chart recorder.

MIP__ Record Results:

The arc was started with the bundle looped and the initiator wires extending through the loop about 0.25 inches. The circuit breaker opened after about 0.125 inches of arc tracking. There was no bundle damage.

7. Remove damaged portion of wire. Reconfigure for next run. Replace any blown fuses and reset CB4 if open.

Run number 2.

8. Close S4. Verify L4, L5, and L6 are illuminated.

9. Start chart recorder. Apply graphite powder to wire sample ends.

10. Terminate this text phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verify by L4, L5, and L6). Stop the chart recorder.

MIP__ Record Results:

The initiator pair was shortened to about 0.125 inches beyond the bundle loop. To start the arc track the entire bundle loop touched the graphite mix.

The circuit breaker opened and both fuses blew after 0.25 inches of arc track into the bundle.

11. Remove damaged portion of wire. Reconfigure for next run. Replace any blown fuses and reset CB4 if open.

Run number 3.

12. Close S4. Verify L4, L5, and L6 are illuminated.

13. Start chart recorder. Apply graphite powder to wire sample ends.

14. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit (verify by L4, L5, and L6). Stop chart recorder.

MIP__ Record Results:

The initiator pair was again 0.125 inches beyond the bundle loop.

The circuit breaker opened after 0.125 inches of arc track. No fuses blew.

15. Remove test sample. Remove fuses. Open circuit breakers. Remove power from WTCB.

PART B: TEST OF JSC PREPARED BUNDLE CARRYING DC POWER (6 PAIR BUNDLE WITH 3 PAIR POWERED).

1. Modify WTCB circuit configuration to Figure 1A.
Attach a jumper on the WTCB from DC Tie to AC Input PH A , PH B, and PH C. Jumper the DC Input (-) to AC Input Neu.

MIP__ 2. Verify test readiness with DC power per previous instructions.
Prepare a 10 foot long wire bundle with the following orbiter type wires: 1 twisted pair Awg #24, one twisted pair Awg #22, 1 twisted pair Awg #20, 2 twisted pairs Awg #16, and 1 twisted pair Awg #12. Spot-tie this bundle every 2 inches. Terminate one wire of the Awg #24 pair to pin 1 (3 Amp RPC output) and the other wire to pin 4. Terminate one wire of the Awg #22 pair to pin 2 (5 Amp RPC output) and the other wire to pin 4. Terminate one wire of a Awg #16 pair to pin 3 (10 Amp CB output) and the other wire to pin 4. This Awg #16 pair will be the initiator wire, extending 0.5 inches beyond the other wires. Terminate the Awg 20 pair to pins 5 and 8. Terminate the Awg 12 pair to pins 6 and 8. Terminate the other Awg 16 pair to pins 7 and 8. separate, slightly, the ends of all pairs except the igniter pair.

VOLTS = 29.65

Run number 1.

3. Close CB2,CB3, and S3. Verify that L3 illuminated.

4. Close S1. Verify that L1 has illuminated.

5. Close S2. Verify that L2 has illuminated.

6. Start chart recorder.
Apply graphite powder to wire sample ends.

7. Terminate this test phase by opening S1, S2, and S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit.
Stop chart recorder. Open CB2 and CB3 if closed.

MIP__ Record Results:

The initiator wire circuit breaker opened after 1.0 inches of arc track, 0.5 inches of which was into the bundle. No other protection device opened.

8. Close CB4.
   Start chart recorder. Close S4. Verify voltage between WTCB pins 5 and 8.

9. Terminate this test by opening S4 after a maximum wait period of one minute, or after arcing has traveled a maximum of 6 inches, or circuit protection device (CB4) has opened the circuit.
   Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened immediately. Obviously the short circuit was still there.

10. Open CB4 if closed. Install a 20 Amp fuse in F3.

11. Start chart recorder.
    Close S4. Verify voltage between WTCB pins 6 and 8.

12. Terminate this test by opening S4 after a maximum wait period of one minute, or after arcing has traveled a maximum of 6 inches, or circuit protection device (F3) has opened the circuit.
    Stop chart recorder.

MIP__ Record Results:

Nothing occurred.

13. Remove F3 fuse. Install a 15 amp fuse in F4.

14. Start chart recorder.
    Close S4. Verify voltage between WTCB pins 7 and 8.

15. Terminate this test by opening S4 after a maximum wait period of one minute, or after arcing has traveled a maximum of 6 inches, or circuit protection device (F4) has opened the circuit.
    Stop chart recorder.

MIP__ Record Results:

Immediately the wire flamed and the fuse blew. This demonstrated that wires adjacent to shorted wires in a damaged bundle can re-initiate arcing if they are subsequently energized.

16. Remove fuse from F4.

17. Remove damaged portion of wiring. Reconfigure igniter wires and other wiring for a repeat run.

Run number 2

18. Close CB2,CB3, and S3. Verify that L3 illuminated.

19. Close S1. Verify that L1 has illuminated.

20. Close S2. Verify that L2 has illuminated.

21. Start chart recorder.
Apply graphite powder to wire sample ends.

22. Terminate this test phase by opening S1, S2, and S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit.
Stop chart recorder. Open CB2 and CB3 if closed.

MIP__ Record Results:

First try - The circuit breaker opened after 0.25 inches of arc track. The arcing did not reach the bundle.
Second try - The wires separated. There was no arc tracking. The bundle was not damaged.

23. Close CB4.
Start chart recorder. Close S4. Verify voltage between WTCB pins 5 and 8.

24. Terminate this test by opening S4 after a maximum wait period of one minute, or after arcing has traveled a maximum of 6 inches, or circuit protection device (CB4) has opened the circuit.
Stop chart recorder.

MIP__ Record Results:

Nothing occurred.

25. Open CB4 if closed. Install a 20 Amp fuse in F3.

26. Start chart recorder.
Close S4. Verify voltage between WTCB pins 6 and 8.

27. Terminate this test by opening S4 after a maximum wait period of one minute, or after arcing has traveled a maximum of 6 inches, or circuit protection device (F3) has opened the circuit.
Stop chart recorder.

MIP__ Record Results:

Nothing occurred.

28. Remove F3 fuse. Install a 15 amp fuse in F4.

29. Start chart recorder.
Close S4. Verify voltage between WTCB pins 7 and 8.

30. Terminate this test by opening S4 after a maximum wait period of one minute, or after arcing has traveled a maximum of 6 inches, or circuit protection device (F4) has opened the circuit.
Stop chart recorder.

MIP__ Record Results:

Nothing occurred.

31. Remove fuse from F4.

32. Remove damaged portion of wiring. Reconfigure igniter wires and other wiring for a repeat run.

Run number 3.

33. Close CB2,CB3, and S3. Verify that L3 illuminated.

34. Close S1. Verify that L1 has illuminated.

35. Close S2. Verify that L2 has illuminated.

36. Start chart recorder.
Apply graphite powder to wire sample ends.

37. Terminate this test phase by opening S1, S2, and S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit.
Stop chart recorder. Open CB2 and CB3 if closed.

MIP__ Record Results:

The circuit breaker opened after 1.0 inch of arc track with damage to the bundle.

38. Close CB4. Start chart recorder.
Close S4. Verify voltage between WTCB pins 5 and 8.

39. Terminate this test by opening S4 after a maximum wait period of one minute, or after arcing has traveled a maximum of 6 inches, or circuit protection device (CB4) has opened the circuit.
Stop chart recorder.

MIP__ Record Results:

Nothing occurred.

40. Open CB4 if closed. Install a 20 Amp fuse in F3.

41. Start chart recorder.
Close S4. Verify voltage between WTCB pins 6 and 8.

42. Terminate this test by opening S4 after a maximum wait period of one minute, or after arcing has traveled a maximum of 6 inches, or circuit protection device (F3) has opened the circuit.
Stop chart recorder.

MIP__ Record Results:

Nothing occurred.

43. Remove F3 fuse. Install a 15 amp fuse in F4.

44. Start chart recorder.
Close S4. Verify voltage between WTCB pins 7 and 8.

45. Terminate this test by opening S4 after a maximum wait period of one minute, or after arcing has traveled a maximum of 6 inches, or circuit protection device (F4) has opened the circuit.
Stop chart recorder.

MIP__ Record Results:

Nothing occurred.

46. Remove fuse from F4.

47. Remove damaged portion of wiring. Remove bundle from the WTCB and test fixture.

PART C: TEST OF JSC PREPARED LARGE BUNDLE CARRYING DC POWER (3 RUNS WITH POWERED WIRES EXTERNALLY LOCATED AND 3 RUNS WITH POWERED WIRES INTERNALLY LOCATED).

1. Using wires in the bundles from test parts A and B, prepare a larger bundle placing the three powered wire pairs next to each other on the bundle exterior. Attach the same wires to WTCB pins 1, 2, 3, and 4 as attached in Part B. The same Awg #16 initiator pair, attached to pins 3 and 4, is to extend 0.5 inches beyond the bundle. Separate the ends of the other powered wires slightly.

MIP___ VOLTS = 29.34

Run number 1.

2. Reset CB2 if open. Verify CB3 closed. Close S3. Verify that L3 illuminated.

3. Close S1. Verify that L1 illuminated.

4. Close S2. Verify that L2 illuminated.

5. Start chart recorder. Apply graphite powder to wire sample ends.

6. Terminate this test phase by opening S1, S2, and S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit. Stop chart recorder.

MIP__ Record Results:

The initiator wire circuit breaker opened after 1.5 inches of arc tracking, extending into the bundle. There was bundle damage but the other powered wires did not short circuit.

7. Remove damaged portion of wiring. Reconfigure for next run. Reset CB2 if open. Verify that CB3 closed.

Run number 2.

8. Close S3. Verify that L3 illuminated.

9. Close S1. Verify that L1 illuminated.

10. Close S2. Verify that L2 illuminated.

11. Start chart recorder.
    Apply graphite powder to wire sample ends.

12. Terminate this test phase by opening S1, S2, and S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit.
    Stop chart recorder.

MIP__ Record Results:

After 2.0 inches of arc tracking, the circuit breaker opened and both RPCs tripped. There was extensive bundle damage in the immediate area.

13. Remove damaged portion of wiring. Reconfigure for next run. Reset CB2 if open. Verify that CB3 closed.

Run number 3.

14. Close S3. Verify that L3 illuminated.

15. Close S1. Verify that L1 illuminated.

16. Close S2. Verify that L2 illuminated.

17. Start chart recorder.
    Apply graphite powder to wire sample ends.

18. Terminate this test phase by opening S1, S2, and S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit.
    Stop chart recorder.

MIP__ 19. Record Results:

After 1.5 inches of arc tracking the circuit breaker opened. RPC #2 also tripped.

20. Remove damaged portion of wiring. Verify all circuit breakers open. Remove wire bundle from WTCB and test fixture.

MIP__ 21. Reconfigure the bundle, placing the power wires in the center of the bundle.

22. Attach the same wires to the WTCB as in previous runs of this test part. The same Awg #16 wire is to extend 0.5 inches beyond the bundle.

Run number 4.

23. Close CB2 and CB3.
Close S3. Verify that L3 illuminated.

24. Close S1. Verify that L1 illuminated.

25. Close S2. Verify that L2 illuminated.

26. Start chart recorder.
Apply graphite powder to wire sample ends.

27. Terminate this test phase by opening S1, S2, and S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit.
Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 1.0 inch of arc track. Slight bundle damage but no other protection devices tripped.

28. Remove damaged portion of wiring. Reconfigure for next run.
Reset CB2 if open. Verify that CB3 closed.

Run number 5.

29. Close S3. Verify that L3 illuminated.

30. Close S1. Verify that L1 illuminated.

31. Close S2. Verify that L2 illuminated.

32. Start chart recorder.
Apply graphite powder to wire sample ends.

33. Terminate this test phase by opening S1, S2, and S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit.
Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 0.5 inches of arc track. The arc extinguished at the bundle interface.

34. Remove damaged portion of wiring. Reconfigure for next run. Reset CB2 if open. Verify that CB3 closed.

Run number 6.

35. Close S3. Verify that L3 illuminated.

36. Close S1. Verify that L1 illuminated.

37. Close S2. Verify that L2 illuminated.

38. Start chart recorder.
Apply graphite powder to wire sample ends.

39. Terminate this test phase by opening S1, S2, and S3 after arcing has traveled a maximum of 6 inches or circuit protection device has opened the circuit.
Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 1.0 inch of arc track, causing bundle damage.

40. Remove damaged portion of wiring. Verify that all circuit breakers are open. Remove wire bundle from WTCB and test fixture.

PART D: TEST OF ROCKWELL PREPARED WIRE BUNDLES DUPLICATING ORBITER BUNDLES (PROCEDURES T.B.D.).

This test requirement was deleted.

VIII DETERMINE THE EFFECTS OF ORBITER CIRCUIT PROTECTION DEVICES ON ALL SIZES OF WIRE USED.

A. DC POWER WIRING

1. Verify DC power off.

2. With the WTCB configured as in Figure 1A, attach one jumper from DC Tie to AC Input PH A, PH B, and PH C. Attach another jumper from DC Input - to AC Input Neu.

3. Verify S1,S2,S3, and S4 open.

4. Verify fuse holders empty and circuit breakers open.

MIP___ 5. Connect a AWG 26, twisted pair shielded cable to pin 5 and pin 4. Connect the shield to pin 4. Remove 0.5 inches of shield from the initiation end of the cable.

6. Apply 28 +/- 4 vdc at the input of the WTCB.

MIP___ Volts = 29.48

7. Verify recorder hookup.

8. Verify fume extractor on.

9. Test with 3 Amp CB (3 times).
Run Number 1
Close CB4 and S4.

10. Verify voltage between WTCB pins 5 and 8.

11. Start chart recorder.
Apply graphite powder to wire sample end.

12. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or CB4 opens. Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 0.25 inches of arc track.

13. Remove damaged portion of the test sample.
    Close CB4 if open.

14. Run number 2
    Close S4. Verify voltage between WTCB pins 5 and 8.

15. Start chart recorder.
    Apply graphite powder to the wire sample end.

16. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB4 opens (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 0.25 inches of arc track.

17. Remove damaged portion of the test sample.
    Close CB4 if open.

18. Run Number 3.
    Close S4. Verify voltage between WTCB pins 5 and 8.

19. Start chart recorder.
    Apply graphite powder to the wire sample end.

20. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or CB4 opens. Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 2.0 inches of arc tracking. Wire damage was extensive.

21. Remove damaged portion of the test sample.
    Install a 3 amp fuse in F2. Verify CB4 open.

22. Test with 3 amp fuse (3 times).
    Run number 1.
    Close S4.

23. Verify voltage between WTCB pins 5 and 8.

24. Start chart recorder.
    Apply graphite powder to the wire sample ends.

25. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or F2 blows. Stop chart recorder.

MIP__ Record Results:

The fuse blew after 0.5 inches of arc track.

26. Remove damaged portion of the test sample.
Replace F2 (3 amp).

27. Run number 2.
Close S3. Verify L4 is illuminated.

28. Start chart recorder.
Apply graphite powder to the wire sample ends.

29. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F2 blows (verified by L4 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew immediately. There was no arc tracking.

30. Remove damaged portion of the test sample.
Replace F2 (3 amp).

31. Run number 3.
Close S4. Verify voltage between WTCB pins 5 and 8.

32. Start chart recorder.
Apply graphite powder to the wire sample ends.

33. Terminate this test phase by opening S4 after arcing has traveled a maximum of 6 inches or F2 blows. Stop chart recorder.

MIP__ Record Results:

The fuse blew immediately. There was no arc tracking.

34. Remove damaged portion of the test sample.
Remove fuse F2.

35. Move wire from pin 5 to pin 1 of the WTCB.

36. Test with a 3 amp RPC (3 times).
Run number 1

37. Close CB3 and S3.
Close S1 and verify L1 is illuminated.

38. Start chart recorder.
Apply graphite powder to the wire sample ends.

39. Terminate this test phase by opening S1 after arcing has traveled a maximum of 6 inches or RPC1 trips (verified by L1 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped immediately. There was no arc tracking.

40. Remove damaged portion of the test sample.

41. Run number 2
Close S1 and verify L1 is illuminated.

42. Start chart recorder.
Apply graphite powder to the wire sample ends.

43. Terminate this test phase by opening S1 after arcing has traveled a maximum of 6 inches or RPC1 trips (verified by L1 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped immediately. There was no arc tracking.

44. Remove damaged portion of the test sample.

45. Run number 3
Close S1 and verify L1 is illuminated.

46. Start chart recorder.
Apply graphite powder to the wire sample ends.

47. Terminate this test phase by opening S1 after arcing has traveled a maximum of 6 inches or RPC1 trips (verified by L1 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped immediately. There was no arc tracking.

48. Remove damaged portion of the test sample. Remove test sample from the test fixture and WTCB.

49. Remove power from the WTCB.

50. Reconfigure WTCB to original configuration as shown in Figure 1. This requires the removal of a jumper and change of CB2 and CB3 outputs.

51. Connect a AWG 24 twisted pair sample to pins 3 and 4 of the WTCB.

52. Apply 28 +/- 4 vdc at the input of WTCB.

MIP____ Volts = 29.37

53. Test with 5 amp CB (3 times).
Run number 1.

54. Close CB1 and S3. Verify L3 is illuminated.

55. Start chart recorder.
Apply graphite powder to the wire sample ends.

56. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB1 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after less than 0.25 inches of arc tracking.

57. Remove damaged portion of the test sample.
Close CB1 if open.

58. Run number 2.
Close S3. Verify L3 is illuminated.

59. Start chart recorder.
Apply graphite powder to the wire sample ends.

60. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB1 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 3.0 inches of arc tracking.

61. Remove damaged portion of the test sample.
Close CB1 if open.

62. Run number 3.
Close S3. Verify L3 is illuminated.

63. Start chart recorder.
Apply graphite powder to the wire sample ends.

64. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB1 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 3.0 inches of arc tracking.

65. Remove damaged portion of the test sample.
Open CB1 if closed.

66. Test with 5 amp fuse (3 times).
Run number 1.
Install a 5 amp fuse in F1. Close S3. Verify L3 is illuminated.

67. Start chart recorder.
Apply graphite powder to the wire sample ends.

68. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew immediately. There was no arc tracking.

69. Remove damaged portion of the test sample.
Replace F1 fuse (5 amp).

70. Run number 2.
Close S3. Verify L3 is illuminated.

71. Start chart recorder.
Apply graphite powder to the wire sample ends.

72. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew immediately. There was no arc tracking.

73. Remove damaged portion of the test sample.
Replace F1 fuse (5 amp).

74. Run number 3.
Close S3. Verify L3 is illuminated.

75. Start chart recorder.
Apply graphite powder to the wire sample ends.

76. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew immediately. There was no arc tracking.

77. Remove damaged portion of the test sample.
Remove fuse F1 .

78. Test with 5 amp RPC (3 times).
Run number 1.
Move wire from pin 3 to pin 2 of WTCB. Close CB3, S3 and S2. Verify L2 is illuminated.

79. Start chart recorder.
Apply graphite powder to the wire sample ends.

80. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC2 trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped after 1.0 inch of arc track.

81. Remove damaged portion of the test sample.

82. Run number 2.
Close S2. Verify L2 is illuminated.

83. Start chart recorder.
Apply graphite powder to the wire sample ends.

84. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC2 trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped immediately. There was no arc tracking.

85. Remove damaged portion of the test sample.

86. Run number 3.
Close S2. Verify L2 is illuminated.

87. Start chart recorder.
Apply graphite powder to the wire sample ends.

88. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC2 trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped immediately. There was no arc tracking.

89. Remove damaged portion of the test sample.
Open S3. Remove the AWG 24 wire from the test fixture and the WTCB.

90. Connect a AWG 22 twisted pair sample to pins 3 and 4 of the WTCB.

91. Test with 8 amp fuse (3 times).
Run number 1.
Install 8 amp fuse in F1. Close S3 and verify L3 is illuminated.

92. Start chart recorder.
Apply graphite powder to the wire sample ends.

93. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The operator opened the circuit after 6.0 inches of arc tracking. The fuse did not blow.

94. Remove damaged portion of the test sample.
Replace F1 fuse (8 amp).

95. Run number 2.
Close S3. Verify L3 is illuminated.

96. Start chart recorder.
Apply graphite powder to the wire sample ends.

97. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 2.0 inches of arc tracking.

98. Remove damaged portion of the test sample.
Replace F1 fuse (8 amp).

99. Run number 3.
Close S3. Verify L3 is illuminated.

100. Start chart recorder.
Apply graphite powder to the wire sample ends.

101. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 0.75 inches of arc tracking.

102. Remove damaged portion of the test sample.
Remove F1 fuse.

103. Test with 7.5 amp RPC (3 times).
Remove wire test sample from the WTCB. Install a 7.5 amp RPC on the WTCB (RPC2). Attach the wire test sample to pins 2 and 4 of the WTCB.

104. Run number 1.
Close CB3, S2, and S3. Verify L2 is illuminated.

105. Start chart recorder.
Apply graphite powder to the wire sample ends.

106. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The wires separated and opened the circuit after 1.0 inch of arc track. The RPC did not trip.

107. Remove damaged portion of the test sample.

108. Run number 2.
Close S2. Verify L2 is illuminated.

109. Start chart recorder.
Apply graphite powder to the wire sample ends.

110. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped after 1.5 inches of arc tracking.

111. Remove damaged portion of the test sample.

112. Run number 3.
Close S2. Verify L2 is illuminated.

113. Start chart recorder.
Apply graphite powder to the wire sample ends.

114. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC trips (verified by L2 extinguished) Stop chart recorder.

MIP__ Record Results:

The RPC tripped immediately. There was no arc track.

115. Remove damaged portion of the test sample. Open CB3. Detach the test sample from the WTCB.

116. Test with 7 amp CB (3 times).
Install a 7 amp CB at pin 3 of the WTCB. Attach the wire test sample to the CB output and to 4 of the WTCB. Attach a voltmeter across the CB output and pin 4.

117. Run number 1.
Close CB3, the 7 amp CB, and S3. Verify L3 is illuminated and voltage on the voltmeter.

118. Start chart recorder.
Apply graphite powder to the wire sample ends.

119. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or the 7 amp CB trips (verified by loss of voltage on the voltmeter). Stop chart recorder.

MIP__ Record Results:

The operator opened the circuit after 6.0 inches of arc tracking. The circuit breaker did not open.

120. Remove damaged portion of the test sample. Reset or verify CB 3 and attached CB (7 amp) closed.

121. Run number 2.
Close S3. Verify L3 is illuminated and voltage on the voltmeter.

122. Start chart recorder.
Apply graphite powder to the wire sample ends.

123. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or the 7 amp CB trips (verified by loss of voltage on the voltmeter). Stop chart recorder.

MIP__ Record Results:

The operator opened the circuit after 6.0 inches of arc tracking. The circuit breaker did not open.

124. Remove damaged portion of the test sample. Reset or verify CB 3 and attached CB (7 amp) closed.

125. Run number 3.
Close S3. Verify L3 is illuminated and voltage on the voltmeter.

126. Start chart recorder.
Apply graphite powder to the wire sample ends.

127. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or the 7 amp CB trips (verified by loss of voltage on the voltmeter). Stop chart recorder.

MIP__ Record Results:

The operator opened the circuit after 6.0 inches of arc tracking. The circuit breaker did not open.

128. Remove damaged portion of the test sample. Remove the 7 amp CB, the voltmeter, and the AWG 22 test sample from the fixture and WTCB.

129. Connect a AWG 20 twisted pair sample to pins 3 and 4 of the WTCB.

130. Test with 10 amp CB (3 times).
Run number 1.
Close S3 and CB2. Verify L3 is illuminated.

131. Start chart recorder.
Apply graphite powder to the wire sample ends.

132. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB2 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 5.5 inches of arc track.

133. Remove damaged portion of the test sample.
Reset or verify CB2 closed.

134. Run number 2.
Close S3. Verify L3 is illuminated.

135. Start chart recorder.
Apply graphite powder to the wire sample ends.

136. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB2 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 3.0 inches of arc track.

137. Remove damaged portion of the test sample.
Reset or verify CB2 closed.

138. Run number 3.
Close S3. Verify L3 is illuminated.

139. Start chart recorder.
Apply graphite powder to the wire sample ends.

140. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB2 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 6.0 inches of arc track.

141. Remove damaged portion of the test sample.
Open or verify CB2 opened.

142. Test with 10 amp fuse (3 times).
Run number 1.
Install 10 amp fuse in F1. Close S3 and verify L3 is illuminated.

143. Start chart recorder.
Apply graphite powder to the wire sample ends.

144. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 1.0 inch of arc track.

145. Remove damaged portion of the test sample.
Replace F1 fuse (10 amp)

146. Run number 2.
Close S3. Verify L3 is illuminated.

147. Start chart recorder.
Apply graphite powder to the wire sample ends.

148. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 1.0 inch of arc track.

149. Remove damaged portion of the test sample.
Replace F1 fuse (10 amp).

150. Run number 3.
Close S3. Verify L3 is illuminated.

151. Start chart recorder.
Apply graphite powder to the wire sample ends.

152. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The wires separated and opened the circuit after 1.0 inch of arc track. The fuse did not blow.

153. Remove damaged portion of the test sample.
Remove F1 fuse.

154. Test with 10 amp RPC (3 times).
Remove wire test sample from the WTCB. Install a 10 amp RPC on the WTCB (RPC2). Attach the wire test sample to pins 2 and 4 of the WTCB.

155. Run number 1.
Close CB3, S2, and S3. Verify L2 is illuminated.

156. Start chart recorder.
Apply graphite powder to the wire sample ends.

157. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped immediately. There was no arc tracking.

158. Remove damaged portion of the test sample.

159. Run number 2.
Close S2. Verify L2 is illuminated.

160. Start chart recorder.
Apply graphite powder to the wire sample ends.

161. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped after 0.125 inches of arc track.

162. Remove damaged portion of the test sample.

163. Run number 3.
Close S2. Verify L2 is illuminated.

164. Start chart recorder.
Apply graphite powder to the wire sample ends.

165. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped after 0.125 inches of arc track.

166. Remove damaged portion of the test sample. Detach the test sample from the WTCB.

167. Connect a AWG 16 twisted pair sample to pins 3 and 4 of the WTCB.

168. Test with 10 amp CB (3 times).
Run number 1.
Open CB3 and close CB2. Close S3 and verify L3 is illuminated.

169. Start chart recorder.
Apply graphite powder to the wire sample ends.

170. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB2 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The wires separated and opened the circuit after 0.5 inches of arc track.
The circuit breaker did not open.

171. Remove damaged portion of the test sample.
Reset or verify CB2 closed.

172. Run number 2.
Close S3. Verify L3 is illuminated.

173. Start chart recorder.
Apply graphite powder to the wire sample ends.

174. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB2 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 2.0 inches of arc track.

175. Remove damaged portion of the test sample.
Reset or verify CB2 closed.

176. Run number 3.
Close S3. Verify L3 is illuminated.

177. Start chart recorder.
Apply graphite powder to the wire sample ends.

178. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB2 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 2.0 inches of arc track.

179. Remove damaged portion of the test sample.
Open CB2.

180. Test with 15 amp fuse (3 times).
Run number 1.
Install 15 amp fuse in F1. Close S3 and verify L3 is illuminated.

181. Start chart recorder.
Apply graphite powder to the wire sample ends.

182. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 3.0 inches of arc track.

183. Remove damaged portion of the test sample.
Replace F1 fuse (15 amp)

184. Run number 2.
Close S3. Verify L3 is illuminated.

185. Start chart recorder.
Apply graphite powder to the wire sample ends.

186. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 1.5 inches of arc track.

187. Remove damaged portion of the test sample.
Replace F1 fuse (15 amp).

188. Run number 3.
Close S3. Verify L3 is illuminated.

189. Start chart recorder.
Apply graphite powder to the wire sample ends.

190. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 1.5 inches of arc track.

191. Remove damaged portion of the test sample.
Remove F1 fuse. Replace the AWG 16 test sample with a AWG 12 test sample.

192. Test with 20 amp CB (3 times).
Run number 1.
Close CB3. Close S3 and verify L3 is illuminated.

193. Start chart recorder.
Apply graphite powder to the wire sample ends.

194. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 2.0 inches of arc track.

195. Remove damaged portion of the test sample.
Reset or verify CB3 closed.

196. Run number 2.
Close S3. Verify L3 is illuminated.

197. Start chart recorder.
Apply graphite powder to the wire sample ends.

198. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 2.0 inches of arc track.

199. Remove damaged portion of the test sample.
Reset or verify CB3 closed.

200. Run number 3.
Close S3. Verify L3 is illuminated.

201. Start chart recorder.
Apply graphite powder to the wire sample ends.

202. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 1.0 inch of arc track.

203. Remove damaged portion of the test sample.
Open CB3.

204. Test with 20 amp fuse (3 times).
Run number 1.
Install a 20 amp fuse in F1. Close S3 and verify L3 is illuminated.

205. Start chart recorder.
Apply graphite powder to the wire sample ends.

206. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 0.5 inches of arc track.

207. Remove damaged portion of the test sample.
Replace F1 fuse (20 amp)

208. Run number 2.
Close S3. Verify L3 is illuminated.

209. Start chart recorder.
Apply graphite powder to the wire sample ends.

210. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 0.5 inches of arc track.

211. Remove damaged portion of the test sample.
Replace F1 fuse (20 amp).

212. Run number 3.
Close S3. Verify L3 is illuminated.

213. Start chart recorder.
Apply graphite powder to the wire sample ends.

214. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or fuse F1 blows (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The fuse blew after 0.5 inches of arc track.

215. Remove damaged portion of the test sample.
Remove F1 fuse.

216. Test with 20 amp RPC (3 times).
Remove wire test sample from the WTCB. Install a 20 amp RPC on the WTCB (RPC2). Attach the wire test sample to pins 2 and 4 WTCB.

217. Run number 1.
Close CB1, CB2, CB3, S2, and S3. Verify L2 is illuminated.

218. Start chart recorder.
Apply graphite powder to the wire sample ends.

219. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or RPC trips. Stop chart recorder.

MIP__ Record Results:

The RPC tripped after 0.25 inches of arc track.

220. Remove damaged portion of the test sample.
Verify CB1, CB2, and CB3 are closed.

221. Run number 2.
Close S2. Verify L2 is illuminated.

222. Start chart recorder.
Apply graphite powder to the wire sample ends.

223. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped after 0.5 inches of arc track.

224. Remove damaged portion of the test sample.
Verify CB1, CB2, and CB3 are closed.

225. Run number 3.
Close S2. Verify L2 is illuminated.

226. Start chart recorder.
Apply graphite powder to the wire sample ends.

227. Terminate this test phase by opening S2 after arcing has traveled a maximum of 6 inches or RPC trips (verified by L2 extinguished). Stop chart recorder.

MIP__ Record Results:

The RPC tripped after 0.25 inches of arc track.

228. Remove damaged portion of the test sample. Detach the test sample from the RPC.

229. Connect a AWG 8 twisted pair sample to pins 3 and 4 of the WTCB.

230. Test with 20 amp CB (3 times).
Run number 1.
Open CB1 and CB2. Close CB3. Close S3 and verify L3 is illuminated.

231. Start chart recorder.
Apply graphite powder to the wire sample ends.

232. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 3.0 inches of arc track. Starting the arc tracking was rather difficult.

233. Remove damaged portion of the test sample.
Reset or verify CB3 closed.

234. Run number 2.
Close S3. Verify L3 is illuminated.

235. Start chart recorder.
Apply graphite powder to the wire sample ends.

236. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened the circuit after 0.5 inches of arc tracking.

237. Remove damaged portion of the test sample.
Reset or verify CB3 closed.

238. Run number 3.
Close S3. Verify L3 is illuminated.

239. Start chart recorder.
Apply graphite powder to the wire sample ends.

240. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or CB3 opens (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

The circuit breaker opened after 1.0 inch of arc track.

241. Remove damaged portion of the test sample.
Open CB3.

** Change shunt CS1 in the WTCB to a 30 amp / 50 millivolt shunt.

THIS PORTION OF THE TESTING WAS DELETED

242. Test with 30 amp CB (Simulate a 35 amp fuse) (3 times).
Run number 1.
Close CB2 and CB3. Close S3 and verify L3 is illuminated.

243. Start chart recorder.
Apply graphite powder to the wire sample ends.

244. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or both circuit breakers open (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

DELETED

245. Remove damaged portion of the test sample.
Reset or verify CB2 and CB3 closed.

246. Run number 2.
Close S3. Verify L3 is illuminated.

247. Start chart recorder.
Apply graphite powder to the wire sample ends.

248. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or both circuit breakers open (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

DELETED

249. Remove damaged portion of the test sample.
Reset or verify CB2 and CB3 closed.

250. Run number 3.
Close S3. Verify L3 is illuminated.

251. Start chart recorder.
Apply graphite powder to the wire sample ends.

252. Terminate this test phase by opening S3 after arcing has traveled a maximum of 6 inches or both circuit breakers open (verified by L3 extinguished). Stop chart recorder.

MIP__ Record Results:

DELETED

253. Open all WTCB circuit breakers and switches.

254. Remove test sample from fixture and WTCB.

255. Replace WTCB RPC2 with original 5 amp unit.

THIS CONCLUDES TEST VIII

IX. ADDITIONAL SUPPORT TESTING AS REQUIRED

A. TESTING OF BUNDLES WITH SINGLE CONDUCTORS FEEDING LOADS WITH ISOLATED GROUNDING

The purpose of this test section is to determine if arcing of powered wires with loads to unpowered wires with loads will result in arc tracking and/or energizing of the normally unpowered load.

1. Configure the WTCB as in Figure 1B. Attach one jumper from the DC Tie to AC Input PHA, PHB, and PHC. Attach another jumper from DC Input (-) to AC Neu Input.

2. Attach the test sample to the WTCB as shown in Figure 5. Attach chart recorder to record load voltage as shown i Figure 5.

3. Verify S1, S2, S3, and S4 open.

4. Verify all fuse holders are empty and circuit breakers open.

MIP ____ 5. Verify 28 +/- 4 VDC at input of WTCB.

Volts = 30.03 DC

6. Run Number 1
Close CB2 and install 15 amp fuses in F3 and F4.

7. Close S3. Verify L3 is illuminated. Close S4. Verify voltage at pins 6 and 7 of TB2.

8. Start chart recorder. Verify electrical loading of 3 wires attached to TB1 and TB2.

9. Apply graphite powder to the ignition point as shown in Figure 5.

10. Terminate this test phase by opening S3 and S4 after arcing has traveled a maximum of 6 inches, circuit protection has opened the circuit, or after a maximum trial period of 2 minutes.
Stop chart recorder.

MIP__ Record Results:

There was very little arcing, similar to a switch operation. There was no arc tracking.

11. Remove the damaged portion of test sample.

12. Run Number 2
Verify CB2 closed. If either fuse (F3 or F4) has had a current flow, as shown on the chart recorder, replace it (15 amp).

13. Close S3 and S4. Verify L3 illuminated and voltage at pins 6 and 7.

14. Start chart recorder. Verify electrical loading of 3 wires attached to TB1 and TB2.

15. Apply graphite powder to the ignition point as shown in Figure 5.

16. Terminate this test phase by opening S3 and S4 after arcing has traveled a maximum of 6 inches, circuit protection has opened the circuit, or after a maximum trial period of 2 minutes.
Stop chart recorder.

MIP__ Record Results:

Same result as above.

THE REMAINDER OF THIS TEST WAS CANCELLED.....

17. Remove the damaged portion of test sample. Reconfigure for a repeat run if feasible, if not skip to step 23.

18. Run Number 3
Verify CB2 closed. If either fuse (F3 or F4) has had a current flow, as shown on the chart recorder, replace it (15 amp).

19. Close S3 and S4. Verify L3 illuminated and voltage at pins 6 and 7.

20. Start chart recorder. Verify electrical loading of 3 wires attached to TB1 and TB2.

21. Apply graphite powder to the ignition point as shown in Figure 5.

22. Terminate this test phase by opening S3 and S4 after arcing has traveled a maximum of 6 inches, circuit protection has opened the circuit, or after a maximum trial period of 2 minutes.
Stop chart recorder.

MIP__ Record Results:

NOT PERFORMED

23. Remove the test sample from fixture and WTCB.

THIS CONCLUDES TEST IX-A

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15. Supplementary Notes

16. Abstract

This report presents the results of Kapton wire arc tracking tests performed at JSC in 1990 using test procedure KWATT BB01. The tests were performed to gather data for use in assessing the safety of the Space Shuttle Orbiter wiring which is predominantly Kapton insulated.

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